A Citizen's Guide

to Wildlife Habitat and Natural Resource Inventories in the Nashua River Watershed

Written and compiled by James DeNormandie

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Section 1 - Introduction

Section 1.1 - Why inventory habitat and natural resources?

Baseline information

By inventorying our habitat and natural resources, we will establish a baseline of information that allows us to better protect these resources. This is the primary reason to undertake an inventory. Once a community, neighborhood, town, or county has such baseline information, many decisions can be made in a more informed manner. For instance, once the location of potential well sites is known, steps can be taken to protect these areas so that when they are needed in the future they will provide clean drinking water. The absence of such knowledge could lead to inappropriate land uses within the zone of contribution to the well site.

Creation of active citizen groups

The act of conducting an inventory will likely necessitate a body of citizens or officials that are aware of the important habitat and natural resources existing in the area. Such a group can act as stewards of these resources into the future.

Preparation for future growth

Between 1970 and 2000, the population in the Massachusetts and New Hampshire Nashua River watershed towns has increased from 280,000 to 368,000, with densities increasing from 372 people per square mile to 489 people per square mile. Growth rates in individual towns in the watershed vary greatly. Table 1 below shows these trends for each of the watershed towns.

Table 1. Growth in Nashua River watershed towns

	1970 Population	1990 Population	2000 Population	Percent growth - 1990 to 2000	Percent growth - 1970 to 2000	1970 Density (people/square mile)	2000 Density (people/square mile)
All NRW Towns >10%	279,660	346,794	367,963	6.1	31.6	371.9	489.4
Ashburnham	3,484	5,433	5,546	2.1	59.2	90.1	143.4
Ashby	2,171	2,717	2,845	4.7	31.0	91.2	119.5
Ayer	7393	6,837	7,287	6.6	-1.4	769.3	758.3
Bolton	1,849	3,134	4,148	32.4	124.3	92.8	208.1
Boylston	2,732	3,517	4,008	14.0	46.7	170.4	250.0
Brookline	1167	2,410	4,181	73.5	258.3	59.0	211.5
Clinton	13,383	13,222	13,435	1.6	0.4	2343.8	2352.9
Dunstable	1292	2,236	2,829	26.5	119.0	78.1	170.9
Fitchburg	43,343	41,194	39,102	-5.1	-9.8	1561.9	1409.1
Gardner	19,748	20,125	20,770	3.2	5.2	889.5	935.6
Greenville and Mason	2105	3,444	3,371	-2.1	60.1	68.4	109.6
Groton	5109	7,511	9,547	27.1	86.9	155.9	291.3
Harvard	13,426	12,329	5,981	-51.5	-55.5	509.5	227.0
Holden	12,577	14,628	15,621	6.8	24.2	359.3	446.3
Hollis	2616	5,705	7,015	23.0	168.2	82.4	220.9
Lancaster	6,095	6,661	7,380	10.8	21.1	220.2	266.6
Leominster	32,939	38,145	41,303	8.3	25.4	1140.5	1430.2
Lunenburg	7,419	9,117	9,401	3.1	26.7	280.8	355.8
Milford	6622	11,847	13,535	14.2	104.4	262.6	536.7
Nashua	55820	79,662	86,605	8.7	55.2	1808.2	2805.5
Paxton	3,646	4,047	4,386	8.4	20.3	247.5	297.8
Pepperell	5887	10,098	11,142	10.3	89.3	260.9	493.9
Princeton	1,708	3,189	3,353	5.1	96.3	48.2	94.6
Rutland and Oakham	3,886	6,451	8,026	24.4	106.5	68.9	142.4
Shirley	3,928	5,368	6,303	17.4	60.5	266.7	427.9
Sterling	4,247	6,469	7,257	12.2	70.9	139.2	237.8
Townsend	4,384	8,496	9,198	8.3	109.8	133.4	279.8
West Boylston	6,411	6,611	7,481	13.2	16.7	497.0	579.9
Westminster	4,273	6,191	6,907	11.6	61.6	120.3	194.5

Imagine uniformly distributing these new people and their homes across the landscape. Some would fall in wetlands, some in the middle of water supplies, others on the top of the watershed's hilltops, while still others in the center of existing cities or suburban neighborhoods. Now imagine the results of such haphazard development. Wetlands may be drained in order to place a right of way for the family car, a water supply might become unusable because of an accidental spill of toxic chemicals, and favorite scenic mountain views could be marred by new homes that exist on the top of the mountains.

While the above example is extreme, it points out that our growth patterns already take into account many natural resources such as wetlands and water supplies. Making an effort to collect basic information on wildlife habitat and natural resources will improve the existing knowledge base. Given the numbers of new people that will likely move into the region, we will need as much detailed natural resource information as possible.

An example of the growth pattern typical of suburban areas in Massachusetts

Such information will need to be collected at various scales, from statewide, to regional, to local. In Massachusetts and New Hampshire, municipalities have a lot of power. Municipal boards usually dictate how and what type of developments can take place. For this reason, the fate of our natural resource base is largely dependent on decisions made at the local level.

Continue to place priority on natural resources

Because the citizens of Massachusetts wanted to declare that the state's natural resources were very important to them, in 1972 the Massachusetts Constitution was amended to read: "The people shall have the right to clean air and water, freedom from excessive and unnecessary noise, and the natural, scenic, historic, and aesthetic qualities of their environment; and the protection of the people in their right to the conservation, development and utilization of the agricultural, mineral, forest, water, air and other natural resources is hereby declared to be a public purpose…(Article 97, Massachusetts Constitution)." Conducting inventories of wildlife habitat and natural resources would continue this commitment to resource protection and stewardship by helping the citizenry use its natural resources in a more sustainable manner. Inventorying is a strong tool that this generation can use to insure that vital resources are identified, allowing for steps that will provide protection for future generations.

Section 1.2 - What is a wildlife habitat or natural resource inventory?

Definitions

The terms wildlife, habitat, natural resource, and inventory need to be defined in the context of this document to help us later define the expressions 'wildlife habitat inventory' and 'natural resource inventory'.

Examples of wildlife, habitat and natural resources

Wildlife is simply the amphibians, reptiles, fish, mammals, birds, invertebrates, and plants that live wild in a region. As with all terms, there is debate over exact definitions (see the following websites: http://cc.usu.edu/~rschmidt/wdamage.html, http://srmwww.gov.bc.ca/cdc/request.htm, http://www.ontarioenvirothon.on.ca/Modules/Wildlife/). Many do not consider invertebrates and plants as wildlife. However, as plants and invertebrates can be listed under state and federal regulations, we feel it is appropriate to include them. Some definitions also exclude non-native wildlife (species not native to the area in which they exist) as well as feral animals (domesticated animals that have become wild). For the purposes of this document, it is better to be inclusive, as inventories must identify the many different facets of a particular resource. We define wildlife as all non-domesticated amphibians, reptiles, fish, mammals, birds, invertebrates, and plants that exist in an area.

Habitat refers to the food, water, shelter, and space that animals require for their survival. All animals are adapted to greater or lesser degrees to their surroundings. As a result habitat requirements can vary from very specific to more general. Animals with very specific habitat requirements are known as habitat specialists while animals able to live in a wide variety of

habitats are known as habitat generalists. (http://www.ontarioenvirothon.on.ca/Modules/Wildlife/).

A natural resource is traditionally defined as "a material source of wealth, such as timber, fresh water, or a mineral deposit, that occurs in a natural state and has economic value" (American Heritage Dictionary, 2000). However, many would argue that there are many "natural resources" that cannot be given an economic value. The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (Federal legislation) defines natural resources as the "land, fish, wildlife, biotic, air, water, ground water, drinking water supplies, and other such resources belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by the United States, ... any state or local government, any foreign government [or] any Indian tribe" (42 U.S.C. § 9601[16]). Passive uses such as hiking and fishing are also included. For the purposes of this document, a natural resource is defined as a resource that occurs naturally in an area and that holds value for the region's inhabitants. Value can be economic or non-economic and inhabitants include wildlife.

An inventory is defined as "an evaluation or a survey, as of abilities, assets, or resources" (American Heritage Dictionary 2000). It should list and describe the resources that exist in an area. The information provided by an inventory should not contain value-laden statements or make judgments. However, it should contain enough information so that future decisions can be made based on the information.

Inventories

Given the above definitions, a natural resource inventory compiles and describes the natural resources in a given area, and will sometimes analyze in detail the condition of these resources and how they are functioning. A comprehensive inventory would inventory both biotic (living) and abiotic (non-living) resources that are valuable to humans and to non-human species. A wildlife habitat inventory is really just a special type of natural resource inventory. A wildlife habitat inventory will determine the types of habitat or ecological communities that exist in an area and the wildlife species that this habitat can support. As with a natural resource inventory, a wildlife habitat inventory will consider both biotic and abiotic factors. However, it will focus on only the habitat that is of value to wildlife.

The above definitions of natural resource and wildlife habitat inventories are very broad. Many different types of inventories can fit within these definitions, from simple to complex. Examples of several inventories are described below:

- An informal walk to look for birds, armed with binoculars and a birding field guide, is a simple type of wildlife habitat inventory.
- A comprehensive natural resources inventory completed for a town may contain Geographic Information System (GIS) (for more information on GIS see Appendix VIII) maps, result in the hiring of many expert consultants in the fields of hydrology, botany, and wildlife ecology, and require the hiring of a new staff member to maintain the natural resource database.
- A forest management plan is not technically a natural resource inventory because they usually have management recommendations, which contain value judgments made by the forester. However, a natural resource inventory should be part of a good forest management plan..The resources that have economic value for humans are documented and wildlife habitat may also be considered.
- A comprehensive wetland inventory (as described in the complex aquatic inventories section of appendix I) is a natural resources inventory. It will document the state of the wetland resource and its function. There may also be a wildlife habitat component that describes the wetland communities that are present and the wildlife that live in the wetland. In this example, we see how a wildlife habitat inventory can be a component of a natural resources inventory.

The consequences of not learning about natural resources can be very high, both financially and to our quality of life. For example, investigating and delineating groundwater resources will allow a town to protect its water supplies, insuring an adequate supply of drinking water to current and future townspeople.

In the case of wildlife habitat inventories, quite a few citizens may ask, "What is the use of conducting a wildlife habitat inventory? How will it benefit me? What might be lost if one does not conduct an inventory?" All of the above questions are valid. When it comes down to it, the benefits to collecting wildlife information are less tangible and are often seen over longer periods of time than those derived from more practical natural resource inventories. We list several reasons why conducting wildlife habitat inventories is an important exercise:

- Monitoring wildlife habitat is a good way to determine if the natural systems in a study area are functioning properly; changes over time in the wildlife present may reflect changes to a natural resource that is important to humans.
- Many people are pleased to confirm that they are living in close proximity to wildlife.
- Conducting wildlife habitat inventories may lead to protection of habitat and open space existing in an area.
- Some people feel that we, as humans, are responsible for the stewardship of wildlife communities because of our track record in changing the environment to the detriment of many other species.
- Monitoring wildlife habitat will reveal the presence or absence of species that are protected under Federal and State legislation. The availability of this information can aid developers because they will know what to expect in terms of permitting or other requirements if they choose to develop in an area.
- Monitoring wildlife habitat will help us manage the wildlife so that recreational opportunities such as hunting and fishing are not lost.

Many topics in the field of conservation biology have bearing on the type of inventories that an area might undertake. Appendix IX provides a brief introduction to the field of conservation biology. A discussion of the word biodiversity, a term widely used in the world of conservation, begins this appendix. The sections that follow provide brief descriptions of reserve design theory and landscape-scale conservation planning.

Section 1.3 - How can inventories be used?

Inventories and assessments are simply sources of information. They describe the state of natural resources and wildlife habitat in your area. Some people will use them as a source of information to learn about their area or town. The inventory can also serve as a benchmark or baseline for later inventories. However, when completed in a thorough manner, an inventory can serve as an incredibly powerful tool to accomplish specific goals. In almost all cases, an inventory should be completed with its ultimate use in mind. A natural resources inventory that will be the centerpiece of a groundwater protection plan will collect significantly different information than one that will be used to create a wildlife habitat protection plan. Some of the most common uses of inventories, including suggestions for success, are described below.

Publicize the inventory and use it as an education tool

After weeks, months or even years of working on an inventory, it is crucial that the final stage of distribution be completed effectively. Consider all of the agencies, organizations, boards, libraries, schools, consultants, land trusts, citizens, and other groups that might be interested in the work that was completed. Let them know that the inventory is complete and send them copies if it is financially possible.

Once completed, an inventory represents a great educational opportunity. Prepare a presentation that can be given to all interested parties summarizing the work that is represented in the inventory. Give the presentation multiple times to different organizations around town. The more people that know about the inventory the better.

Start a land protection effort

Once an inventory is complete there are many ways that it can be used to augment protection efforts. A natural resource inventory can be used to prioritize areas of town for conservation attention.

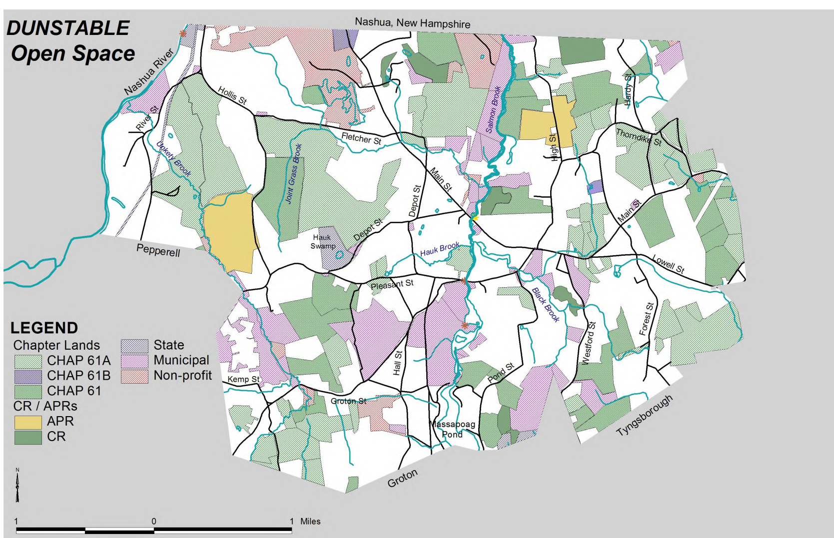
Section 1: Introduction

Another efficient way to consolidate protected areas would be to examine key resource areas located adjacent to existing protected areas. Another possible exercise is an overlay of resource datasets. Areas with a high density of many different resources will identify areas worthy of more conservation attention. Locally based protection efforts can nicely complement protection that is extended through State and Federal regulation or acquisition. Each type of protection (State, Federal, or local) can be successful given the different management styles and goals.

Applying and obtaining grants could also become easier since the inventory can serve as an information base and will indicate to the awarding agency that your town or area is dedicated to resource protection. One example is the completion of a town-wide open space plan. Without an open space plan, a town will not qualify for Self-Help grants available from the state of Massachusetts.

Develop an open space plan

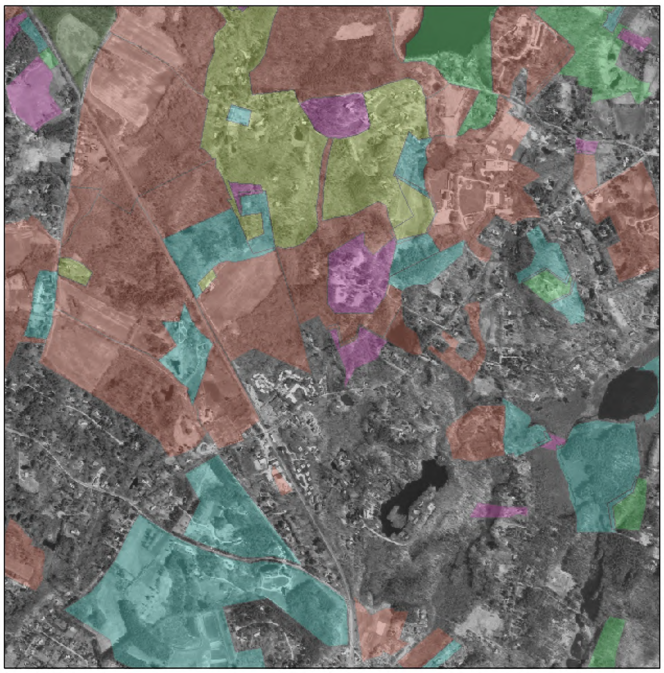
If a natural resource inventory was completed using a Geographic Information System (GIS) (for more information on GIS see Appendix VIII) it can be used as the foundation for a municipality's open space plan. Many of the required components that are needed to complete the open space plan will have been collected in order to complete the natural resource inventory. Additional GIS files such as the parcel database are most helpful. The digital layers can be used to analyze the relationship of town growth patterns to the natural resources. For instance, the relationship of residential development to the pattern of wetlands in a town can be analyzed. Such an analysis may be helpful to the eventual creation of zoning overlay districts to help protect wetland resources. An overlay district is a planning tool used to establish alternative land



A portion of the Dunstable open space plan prepared using GIS development requirements within a special area of your town, such as an environmentally sensitive area or rapidly developing strip corridor

Develop a conservation plan

Completing a conservation plan involves prioritizing areas in town for land conservation as well as creating goals for resource protection. Creating resource protection goals, identifying and ranking key areas, and considering a time frame for protection is the majority of the work needed to create a conservation plan. The information collected for an inventory will be extremely useful in this exercise. Which GIS layers are used will depend on the type of resource that is being protected.



A hypothetical conservation plan for a town showing an acquisition priority scheme

Once a local inventory has been completed you can approach adjacent communities or towns and suggest collaboration in creating regional wildlife protection zones. For instance, if Princeton were to complete a conservation plan, it would make sense to approach the adjacent towns of Leominster, Sterling, West Boylston, Holden, Rutland, Hubbardston and Westminster. Each of these towns contain areas of "core" habitat identified by the Massachusetts Natural Heritage BioMap (see section 3 for a description of the BioMap program). The inventory can serve as an information base to guide regional efforts or as an example to surrounding towns that want to conduct their own inventories.

Screen proposed projects to determine if further information is required

An inventory can be used to screen development proposals for potential impacts on various natural resources or wildlife habitats. It is important to note that it is not appropriate to use most inventories for site specific analysis. However, they can be used as a preliminary assessment tool that saves time for conservation commissions before stepping out into the field.

Develop or update master plans

Master plans should be periodically updated in order to justify the particular suite of land use regulations present in each town. The information collected in an inventory can easily be incorporated into the natural resources / open space / conservation section of the master plan.

Evaluate land use regulations

Many town boards do not realize what impact the current set of bylaws and zoning regulations will have on a town over the long-term. The inventory can be used to conduct "Build-out" analyses for towns. These analyses show the possible future of a town if all of the development that is allowed under the zoning regulations were allowed. This technique will often provide a reason to alter the existing zoning regulations in order to avoid the potential future "Build-out" situation.

The Vermont Fish & Wildlife Department engaged the services of Burnt Rock Inc., Associates in Community Planning to assess how well Vermont municipalities, through the use of local plans and bylaws, address fish and wildlife issues and resources. The result was the document, "Wildlife Considerations in Local Planning: A Vermont Review" (see appendix IV). They reviewed 223 municipal plans and created a database to summarize the results of the review as well as reviewing town bylaws for a much smaller set of municipalities. They recorded information such as regulatory policies recommended, non-regulatory policies recommended, coordination with other jurisdictional levels (state, federal, local, and private organizations), and the perceived public benefits of habitat.

They found that more recently developed municipal plans were much more likely to be comprehensive in scope, detailed in the type of information provided, and specific in defining helpful policies and community objectives. Such plans require much more detailed inventory and mapped data. This trend clearly shows the increasing need and importance for habitat and natural resource inventories in order to support municipal planning efforts.

Assess changes to existing zoning ordinances

If a group of citizens in town is unsure of the potential impacts of regulatory changes, the natural resource inventory data layers can be used to model the potential impact. (See Appendix VI for the definition of the term “data layer”. It is frequently used with reference to a Geographic Information System). For instance, if a wetland bylaw is being considered that will increase the buffer widths around certain wetlands, it would be possible to identify which landowners would be potentially impacted. Many basic analyses similar to the one just described can be completed by simply downloading the relevant data from the MassGIS or GRANIT GIS database and using the capabilities of GIS software. While state GIS data is extremely useful, it should be augmented by locally collected information in order to compile a complete natural resource inventory.

Changing existing town regulations

In addition, the inventory can serve as an information source that drives the changes to zoning bylaws. For instance, the collection of a data layer that delineates the 100-year floodplain could result in the creation of a floodplain overlay district that is incorporated into local zoning bylaws.

Ongoing inventory

Once an assessment has been finished, the steering committee can relax and celebrate its completion. However, with baseline information collected in the assessment, the group of citizens is now poised to begin collecting a time-series of information on the resource. The group should periodically conduct the assessment again. This will allow the detection of changes in the resource that may be negative or unwanted.

Create an educational trail system

The information in the inventory can be used to set up a trail system that is also educational. The inventory will identify places where important natural resources and / or habitat exist. This information can be used to supplement an existing local trail system into a large scale interpretive trail system. Signage can be created to highlight the important resources recently inventoried and discovered.

There is really no end to the types of activities that are made possible by the completion of a habitat or natural resources inventory. In the absence of such inventories, communities are vulnerable to ill-planned development, degradation of local resources, decrease in property value, and a decrease in the quality of life that is currently enjoyed.

Section 1.4 - Intended audience

This guide is written for interested citizens, town officials, as well as groups such as local land trusts. This guide is meant to teach communities in the Nashua River watershed how to inventory the wildlife habitat and natural resources present. It is designed to help them identify the gaps in the knowledge of local natural resources. After these gaps are identified, interested citizens can efficiently channel their limited time, money, and energy into creating a more complete knowledge of local natural resources. The guide is tailored to the Nashua River watershed.

Section 1.5 - Format of the guide

The first section of the document describes why we should conduct inventories of habitat and natural resources. The terms habitat, wildlife, natural resource and inventory are also defined. A brief section describes how inventories can be used, the audience of the guide, and the format of the document.

The second section of the guide describes the steps necessary to define and initiate an inventory with other interested citizens. Topics such as defining the appropriate inventory, selection of a steering committee, publicizing the inventory, and types of possible inventories are discussed.

The third section describes several recent inventories conducted in the Nashua River watershed. These inventories are the statewide BioMap conducted by the Executive Office of Environmental Affairs, the Petapawag and Squannassitt Areas of Critical Environmental Concern (ACEC), and two inventories completed by the Massachusetts Audubon Extension service. "Focus Areas for Wildlife Habitat Protection in the Nashua River Watershed" identifies areas that are priorities for habitat protection from a regional perspective (Collins 2000). Large, medium-sized, and small focus areas are identified as well as the corridors needed to connect the focus areas. The second inventory is a set of five "Natural Community and Wildlife habitat inventories for five areas of the Nashua River watershed" conducted on much smaller areas within the watershed (Collins 2002). The areas are: the "Snake Hill" region of Ayer/Groton, Townsend Hill in Townsend, Wright Ponds in Ashby and Fitchburg, Whitney Hill/Muddy Pond in Ashburnham and Westminster, and Pine Hill in Lancaster. These inventories go into much more detail for each of these sites and are the result of field work in combination with GIS map analysis.

The appendices of this document are extensive and serve to provide citizens with additional information relevant to undertaking inventories of their own.

Appendix I is devoted to describing the different types of inventories that can be conducted. Three sections were created that cover simple inventories, moderate inventories, and complex inventories. The document was broken into these sections so that groups could concentrate on the section that coincides with the amount of time and resources that are available to them. One of the sub-sections in the moderate inventories section describes in detail many different inventory methods that can be used for plants, mammals, birds, reptiles, and amphibians.

Appendix II lists a few more examples of inventories completed in the Nashua River watershed.

Consult the Table of Contents to review the other appendices that the document contains. There are numerous references to the appendices throughout the document. There are many resources that were drawn on in order to create this guide. Given the condensed timeline of the preparation of this document, some portions of the text in this document were copied from other documents. Each time this research technique was used, the original source is mentioned and credit is given.

Section 2 - Defining and initiating the inventory

Section 2.1 - Reasons to undertake local inventories

There are many different reasons to undertake an inventory. The type of inventory will be partially determined by the motivation of the group of citizens. For example, a group might want to foster local appreciation of wildlife through environmental education. If this is the case, it would not be appropriate to undertake a comprehensive inventory of natural resources. Conducting an inventory of vernal pools in order to certify them might be a more appropriate use of time.

Other reasons to undertake inventories are listed below:

- Citizens want to create an information system that will help guide development in a more conscientious manner.
- If you are dedicated to improving wildlife habitat on your property, yet you're not certain which wildlife species are present, a wildlife habitat inventory would be a wise step before developing a management plan.
- If certain native species that used to be present are no longer seen or replaced by non-native "exotic" invasives.
- There is a need for a town-wide natural resources inventory that will be part of a master plan or open space plan.
- To inventory aquatic resources.
- If there is a need to prioritize parcels in order of conservation importance.
- Citizens want to initiate an effort that will result in the adoption of town bylaws that are designed to protect wildlife habitat or important natural resources. It is rare to find one person that can handle both field work and the local political process. Such an effort might involve setting up a committee that involves a naturalist as well as people knowledgeable of local political procedures necessary for this process.

- To develop a regional conservation plan with surrounding towns or develop a town-specific “open space” plan.
- To collect information that will help create an "Action Plan" to protect a specific resource or habitat.

It is important to realize that an inventory is not an end in itself. An inventory is simply a tool or information source that will help accomplish other goals such as those listed above. If an inventory was completed at a town level, beware of trying to use the inventory at too fine a level. Inventories should be used as a screening tool to highlight areas where more in depth assessments are needed. Normally, they should not be used to resolve issues for parcel-sized areas.

Section 2.2 - Define the goal of the project

It is important to define goals early in the project. Some preliminary discussion should take place between the people that initially started the project. Then, the discussion can be opened up to a larger group of people. These discussions should help to fine-tune the goals of the project.

Remember that an inventory is not an end in itself but a tool that helps you accomplish other broader goals. Some helpful questions to ask when articulating the project goals are:

- Why do you want to do an inventory?
- How much time, energy, money or other resources does the group have? These factors, may determine what and how much can be done.
- What will the inventory help you accomplish?
- What are the community's needs and desires?
- Has work already been done in inventorying the habitat or natural resources nearby? (Some of the major efforts to inventory wildlife habitat in the Nashua River watershed are described in Section 3)
- If conducting a town-wide natural resources inventory, are habitat or natural resources goals identified in the master plan or other official town documents? If so, what recommendations are made in the

master plan with respect to natural resources? How can the inventory address recommendations that are not yet implemented?

- What natural resources information should be included in the inventory?
- Are there specific habitat or natural resource priorities in the study area, such as water resources, wetlands, farmlands, endangered or threatened species? Much information on important datasets can be gathered from the websites of state agencies very quickly and easily. In addition, contacting the appropriate person in an agency can be helpful. We have compiled a list of such contacts in Appendix V.

It is helpful to define both short and long term goals. Goals can also be very broad in nature, such as "conservation planning", or can be broken down to very specific tasks, such as “wetlands inventory and evaluation” or “mammal habitat assessment”.

The town of New Ipswich, New Hampshire recently decided to conduct a natural resource inventory (NRI) of their town. The main reason the Conservation Commission undertook the NRI was to create a reliable natural resource data set. In doing this, the town hopes to avoid future conflict between the Conservation Commission and other entities. The town issued an RFP to multiple for-profit organizations and ultimately one firm was selected. The inventory will cost roughly $20,000. The natural resources included in the inventory will be water resources, open lands, slopes, and wildlife resources. The output of the inventory will be presented to the town as GIS layers and a collection of GPS (Global Positioning System – see Appendix VIII) points. These layers of information can then be overlaid onto maps of the town such as tax, parcel, and zoning maps.

There are many different ways that a NRI can be created, using many different resources, from professional to volunteer. In the case of New Ipswich, they decided to hire a professional wetland scientist to create the inventory with the hope of minimizing future conflicts. The decision of the New Ipswich Conservation Commission illustrates that when a municipal organization is choosing how to conduct a natural resources inventory, the reliability of the data must be considered. Conducting a volunteer effort to inventory natural resources can be educational and in many cases very useful to the planning process in a town. A good number of citizens will increase their knowledge of the town's resources. However, a developer is much more likely to seriously question a volunteer-created inventory than one that was compiled by an unbiased professional wetland scientist. Ideally, both of these approaches should be used. A professional natural resources scientist should be used to create a high quality data set to be used by the town. Volunteers can then concentrate efforts on stewardship and monitoring of the most important natural resources of the town as identified by the professional.

Section 2.3 - Determine the scope of the project

Size of the study area

It is crucial to define the study area of the project early on. Efforts to collect information will be focused within the chosen study area. Changing the boundary half way through the inventory will result in costly re-collecting of information that could have been avoided.

A study area can encompass multiple towns, a county, an entire town, an area located within a town, or several separate areas within a town that have similar resources such as wellhead protection zones. If a town is undertaking a natural resource inventory, the town boundary is the appropriate one.

In Massachusetts and New Hampshire, the municipality is the level of governance with much of the power to make decisions. Municipalities usually dictate how and what type of developments can take place. For this reason, the fate of our natural resource base is largely dependent on decisions made at the local level. It makes sense that the town will be the appropriate level at which the inventory is conducted. In order to make good local decisions, municipal officials need to have high quality information available to them.

If you plan to use GIS to aid in your natural resources inventory, consider "buffering" your boundary by an appropriate distance (one mile is usually appropriate for towns) and collecting information on natural resources not only in your town but just beyond it as well. This will place your study area into a wider context area.

Some inventories may involve cooperation between towns. If this is the case, a regional study boundary is appropriate. It should encompass all of the towns that are participating in the inventory. Again, a buffer should be created to place the study area into its larger context area. The size of the buffer will vary depending on the size of the study area. This type of inventory is especially relevant in the Nashua River watershed as both Massachusetts and New Hampshire fall within its boundary. Jursidictional boundaries present a real challenge when trying to conduct regional inventories and efforts to promote inter-state cooperation should be undertaken whenever possible.

When conducting habitat and natural resource assessments, it is often appropriate to disregard political or jurisdictional boundaries in favor of natural boundaries. Use of geological boundaries such as plateaus (or ecoregions) can be appropriate, but a watershed boundary is usually the best choice when using natural boundaries. A watershed is simply all of the area that drains to a given point in the landscape. Usually this means identifying the land area that flows into a particular river or water body, such as the Nashua River watershed. For the purposes of a town, it may be useful to delineate several smaller sub-watersheds that exist (See Appendix VI for definitions that describe the terms used to refer to watersheds of varying size). Then, for example, a water quality monitoring effort can be set up insuring that samples are taken in each sub-watershed. Identification of the boundaries of sub-watersheds will also be useful when identifying potential pollutant sources such as gas stations, and what areas would be impacted if an accident were to occur. GIS software (Watershed Analyst within ArcView 3.2 and 8.2) can be used to delineate a watershed boundary if a digital elevation model (a model of the topography) is available for a study area. For more information on GIS, see Appendix VIII.

Temporal scope

The temporal scope of the inventory will be decided by the goals of the project as well as the time that the work group, volunteers, and the steering committee have to give the undertaking. Conducting a comprehensive natural resources inventory can easily be a multi-year effort. In contrast, conducting an informal neighborhood bird count may take one Saturday afternoon. It often helps to spend some time establishing a rough schedule if you are not sure exactly how long the project will take.

Section 2.4 - Select an appropriate inventory technique

Based on the goal and scope of the project, select one or more of the inventory techniques that are described in detail in appendix I.

Section 2.5 - Establish a steering committee, working group, and initial planning meeting

For more traditional (town-wide) inventories a steering committee and working group should be formed. This will not always be necessary with private or very small inventories. The steering committee will serve as the heart of the inventory effort. The size of the steering committee will depend on the type of inventory. Usually, 3 - 7 individuals who will spend significant effort in accomplishing and organizing the inventory is sufficient. The committee must contain enough individuals so that the group is not overwhelmed with responsibilities. However, it is also important that the committee be small enough so that decisions can be made quickly and efficiently. The working group will be a much larger group of people that can be drawn on when larger inventory tasks present themselves. When forming the steering committee, local experts or other sources of "traditional indigenous knowledge" in your community should be considered such as natural resource specialists, outdoorspeople (hunters, birders, hikers, equestrians), and wildlife ecologists.

Set a date for a planning meeting and begin to invite local organizations and individuals. If the steering committee has not already been formed, you may find potential members as you contact the various organizations outlined below.

Municipal officials: The conservation, open space, historic and recreation commissions; the planning, zoning and select boards; garden club; and the historic society, and other similar local groups should be invited to participate.

Conservation commissions: Town conservation commissions are a good place to initially go for information. In Massachusetts, the first conservation commissions were established in the late 1950s "…for the promotion and development of the natural resources and for the protection of watershed resources of said city or town" (M.G.L. Ch. 40 §8C). The corresponding legislation in New Hampshire was passed in 1963, leading to the creation of conservation commissions, "…for the proper utilization and protection of the natural resources and for the protection of the watershed resources of said city or town" (RSA 36-A:2). State legislation mandates consideration of natural resource issues by this group.

Town or community citizens: Local experts or other sources of “traditional indigenous knowledge” in your community should also be notified of the inventory effort. Natural resource specialists, outdoorspeople (hunters, birders, hikers, equestrians), and wildlife ecologists may live nearby and be available to help with the effort or become a member of the working group. It is also a good idea to check past efforts connected to natural resources or habitat and invite previous participants to join the effort.

Other local groups: Many towns have local land trusts or local preservation groups that might also be contacted. See Appendix V for a listing of relevant agencies for the Nashua River watershed. Local school groups, teachers, and youth groups may also be a good source of enthusiasm and support. Mary Marro of the Nashua River Watershed Association has recently compiled an Environmental Education Alliance database which contains useful information on environmental educators in the watershed.

Local colleges and universities: Sometimes local colleges and universities may become involved in local efforts as a portion of a natural resource class. (See Appendix V for a listing of local universities and education institutions that might help.) If successfully organized, this type of work can be very fruitful and often results in high quality work, as the students are fledgling experts in their field. This method has the added benefit of being typically much less expensive than hiring a professional consultant.

Conducting a natural resource inventory may be greatly facilitated by members of the local conservation commission. While wildlife habitat is a natural resource, not as much attention has been given to it as to wetlands, open space, or ground and surface water. When trying to establish a working group for a habitat inventory, concentrate on finding those that are knowledgeable of local habitat types. Remember to tap resources such as hunters and private landowners, not only those involved with municipal issues. Contacting the members of the local conservation commission might be a good route to finding people to participate in the inventory.

When contacting the above organizations or individuals, briefly describe the inventory goals to them and invite a representative to attend an initial planning meeting. Solicit input along the way as to who would be a good member of the work group. By the time all of the above groups and organizations have been contacted, many potential members of the working group will be identified.

Section 2.6 - Identify the resources that are needed and available

In the ideal world, definition of the goal and scope of an inventory would naturally lead the steering committee to determine the resources that are needed to accomplish the inventory. Unfortunately, we live in a world with finite resources of time, person power, and funding. The resources that are needed for an inventory are not always the resources that are available. For instance, the goal of the project may be to complete a comprehensive natural resources inventory for a town. This will require access to a GIS specialist and GIS software. Upon further inquiry, it may be determined that the cost of hiring a GIS specialist and buying the required technology may be prohibitive. In this case, the goal of the project will need to be altered until the resources that are available are in alignment with the goal and scope of the inventory. Often, the resources that are available (time, energy, and funding) will be the driving force behind the type of inventory that is undertaken.

Existing sources of information

There is no reason to conduct a component of research if it has already been completed by someone else - there are many sources of information that already exist! Conduct an initial search that includes town records, town library, and relevant municipal boards such as the conservation commission, planning board, and regional planning commissions. Other municipal resources to check include:

- Zoning ordinances (such as existing overlay districts) - Contact town planning board members.
- Master plans – Contact town planning board chairperson or town clerk/administrator. Often these documents will have "Natural Resources" sections with relevant information.
- Open Space and Recreation Plans – Contact the town conservation commission chairperson to find out whether an Open Space and Recreation Plan has been completed. These will have sections devoted to inventory of natural resources as well as other relevant information.
- Town bylaws – Contact town planning board members to determine if there are any zoning ordinances that pertain to natural resources or wildlife habitat.

The Nashua River Watershed Association recently completed the "Resource Protection Bylaws, Ordinances and Regulations for the Nashua River Watershed" database. This database has town-specific information regarding bylaws and zoning as well as a model bylaw database. The model bylaws can be used by communities that want to learn more about municipal ordinances useful in protecting natural resources. A copy of this database can be obtained by contacting the Nashua River Watershed Association.

Refer to Appendix V to identify state, private, and non-profit organizations that may have documents relevant to the project and check the Bill Farnsworth Conservation Clearinghouse at the Nashua River Watershed Association River Resource Center as well. We attempted to compile various inventories that have been conducted in the Nashua River watershed by searching existing materials, contacting the local universities listed below, and contacting towns and organizations if relevant documents were brought to our attention.

Universities and colleges can sometimes be the source of detailed and useful information. Students may have chosen an area within the Nashua River watershed as the focus of a thesis or dissertation. If this is the case, very detailed information may be contained in the report. Some of the local institutions that may prove useful are:

- The University of Massachusetts, Amherst Departments of: Landscape Architecture and Regional Planning, Natural Resources Conservation, and Environmental Sciences
- Conway School of Landscape Design
- Antioch New England Graduate School Center for Environmental Education
- Worcester Polytechnic Institute

When collecting GIS data, visit the websites of MassGIS (http://www.state.ma.us/mgis/) and GRANIT (http://www.granit.sr.unh.edu/) for Massachusetts and New Hampshire respectively. There are immense amounts of information that will give a great head start on any inventory. The MassGIS "Online Mapping" website (http://www.state.ma.us/mgis/mapping.htm) and the New Hampshire GRANIT "Create a Map" website (http://www.granit.sr.unh.edu/cgi-bin/load_file?PATH=/create/index.html) are available to map many basic variables quickly. These maps can be printed out as a preliminary step to assembling the GIS data.

Visit the home pages of the various state agencies to find out about the recent projects that are relevant to the inventory. For instance, the Mass Natural Heritage and Endangered Species Program website lists the recently completed BioMap project. This project identifies areas most in need of protection to protect the native biodiversity of the Commonwealth. See Section 3.1 of the document for a more complete description of the BioMap project as well as maps depicting the Core Areas and Supporting Landscapes in the Nashua River watershed.

Funding sources

The costs of the inventory will of course depend on the goal and scope of the project. Below are some common factors that may be relevant when trying to develop a budget for the inventory:

- Cost of GIS specialist
- Potential cost for new hardware and software
- Cost to produce needed GIS maps
- Production costs of final document and color large format maps
- Cost to hire a natural resource specialist or wildlife ecologist
- Cost to hire student interns
- Cost to fund a Masters thesis for a university student if detailed natural resource information is needed

Once a budget is created, determine if the project can be funded internally or whether outside funding sources must be considered. The inventory will be simpler of course if it can be completed using only internal funding sources or no funding sources at all. If external funding sources are needed, consider the following potential sources of municipal funding:

- Contributions from local planning boards and select boards
- Town conservation funds
- Conservation commission funds
- Warrant article at town meeting

- Local Land Trusts
- Contributions from volunteers interested in the effort
- Private donations from individuals or foundations

Please see Appendix X for a description of a variety of funding sources that are available to citizens involved in various inventory-related activities. This Appendix lists many funding sources. However, it is worthwhile to do some searching on one's own due to frequent change in funding opportunities.

Section 2.7 - Publicize from the outset

The value of publicity should not be underestimated. Let townspeople know of the project, either through the local newspaper, town governing bodies, or by giving a presentation (to trails, equestrian or scout groups). The initial publicity serves a twofold purpose: 1) It lets people know the intentions from the beginning, rather than having them discover it far into the process, and 2) People may be identified that are willing to help.

If any private land is located in the study area, it is very important to appropriately contact these landowners. Determine which parcels are privately owned, and contact the landowners to let them know of the intended inventory. Ask them if they will grant permission of entry onto their property in order to inventory the natural resources and/or wildlife habitat located therein. If permission is granted, contact them before the inventory will take place and let them know when and how you will be accessing their property. If permission is not granted, it is useful to let them know when you will be visiting adjacent areas surrounding their property. Outreach efforts to landowners should be conducted delicately and begin very early in the inventory process.

Section 2.8 - Begin work on the inventory

Once the above tasks are completed, the real work of the inventory can begin. By this time you should know the goal of the project, the size of the study area, the timeline of the project, the appropriate inventory technique(s) to use, the people that you can draw on throughout the inventory, and the items that are needed.

Section 3. Recent Inventories in the Nashua River watershed

This section describes recent inventories that were completed in the Nashua River watershed. The MNHESP BioMap project is described and a map of the BioMap core areas was produced to show the pattern of core areas and supporting natural landscape within the watershed. The conclusions of the most recent set of habitat inventories that were completed within the Nashua River watershed by Mass Audubon Ecological Extension Service are summarized. Maps were also created that show the configuration of the Watershed Focal Areas (Figure 1) and the location of the local inventories (Figure 2).

Several other inventory types are also described. A variety of inventory types were selected in order to show citizens the many different types of natural and habitat inventories that are already used within Massachusetts and New Hampshire.

Section 3.1 - Massachusetts BioMap

The BioMap is a recently completed project of the MNHESP, funded by the Executive Office of Environmental Affairs. It identifies the areas that are most in need of protection in the state of Massachusetts. The areas were identified using the MNHESP rare species and exemplary natural communities database. More than 7,000 records are included in the database of rare species. The records include 2,500 rare plant occurrences as well as 750 natural community records.

The final products of the BioMap effort were two state-wide GIS maps: “core habitat” and “supporting natural landscape”. The “core habitat” map identifies the areas of the highest priority for protection based on the occurrences of rare animal species. The “supporting natural landscape” map identifies the buffer areas around the “core habitat” areas that are large and undeveloped, are largely roadless, and are effective connectors of “core” areas.

Within the Massachusetts portion of the Nashua River watershed, there are 57, 750 acres of “core habitat” that were identified (or 16.9% of the Massachusetts portion of the watershed) and 65,640

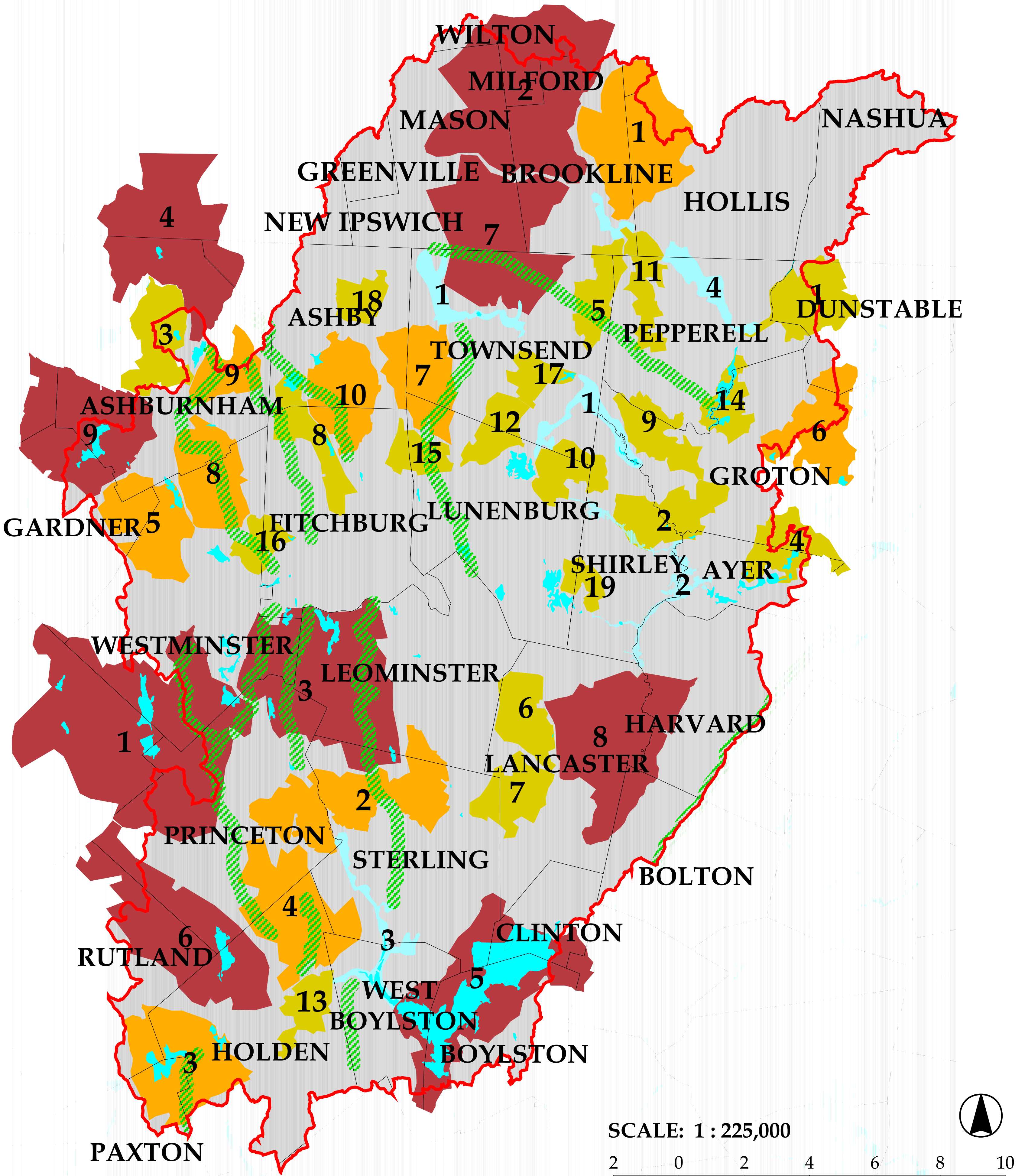


FIGURE 1. Nashua River Watershed Regional Focus Areas and Important Ridgeline Corridors

LEGEND

- Nashua River Watershed Boundary
- Town Boundaries
- Important Ridgeline Corridors

Large Focus Areas

1 Mt. Wachusettt/Hubbardston WMA
2 Badger Hill/Spaulding Brook
3 Leominster State Forest
4 Mt. Watatic
5 Wachusett Reservoir
6 Savage Hill WMA/Quinapoxet Res
7 Townsend State Forest
8 Devens/Oxbow/Bolton Flats
9 Lake Wompanoag

Medium-sized Focus Areas

1 Birch Hill/Rocky Pond
2 Wachusett & Wekepeke Brooks
3 Pine Hill Reservoir
4 Poutwater Pond
5 High Ridge WMA
6 Horse Hill/Baddacook Pond
7 Willard Brook State Forest
8 Whitney Hill/Muddy Pond
9 Mt. Hunger/Russell Hill
10 Wright Ponds

Small Focus Areas

1 Hound Meadow Hill/Hawk Swamp
2 Squannacook Hill
3 Upper Naukeag/Lincoln Pond
4 Snake Hill
5 Townsend Hill
6 McGovern Brook
7 Ballard Hill
8 Falulah Brook
9 The Throne
10 Hunting Hills/Mulpus Brook
11 Gulf Brook
12 Bixby Reservoir/Mulpus Brook
13 Unionville Pond/Quinapoxet Riv
14 J Harry Rich State Forest
15 Pearl Hill Brook
16 Parker Hill
17 Bixby Brook
18 Trapfall Brook
19 Long Swamp/Spruce Swamp

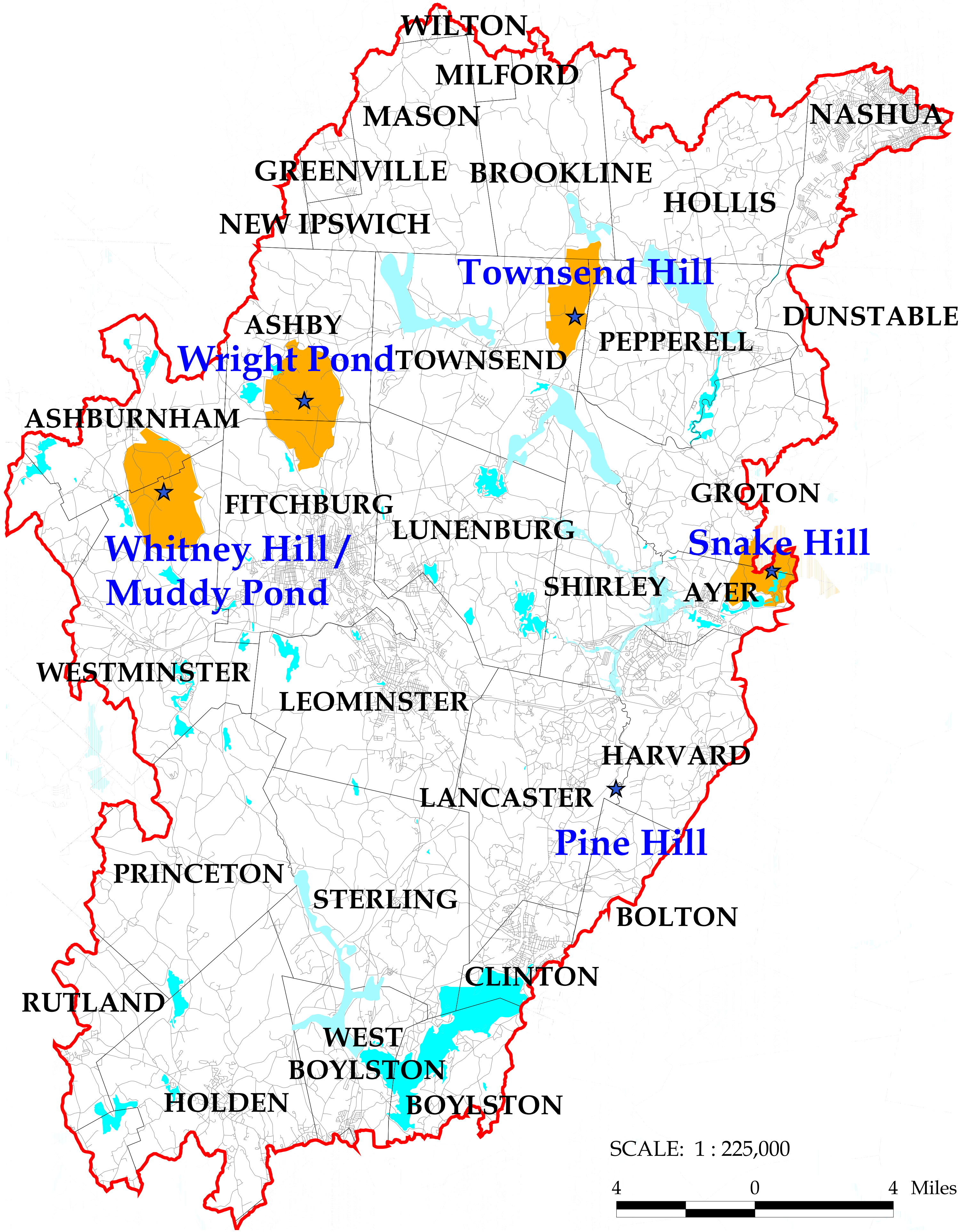
Riparian Corridors

1 Squannacook River
2 Nashua River/Mulpus Brook
3 Stillwater River
4 Nissitissit River

NOTES

The regional focus area GIS data layer was created as part of the Mass Audubon project identifying "Focus Areas for Wildlife Habitat Protection in the Nashua River Watershed". Large, medium, small, and riparian corridor focus areas were identified as having high conservation value.

FIGURE 2. Location of Five Natural Community and Wildlife Habitat Inventories Conducted in the Nashua River Watershed



LEGEND

- Nashua River Watershed Boundary
- Other_nrw_inventories.shp
- Town Boundaries
- Inventory Locations

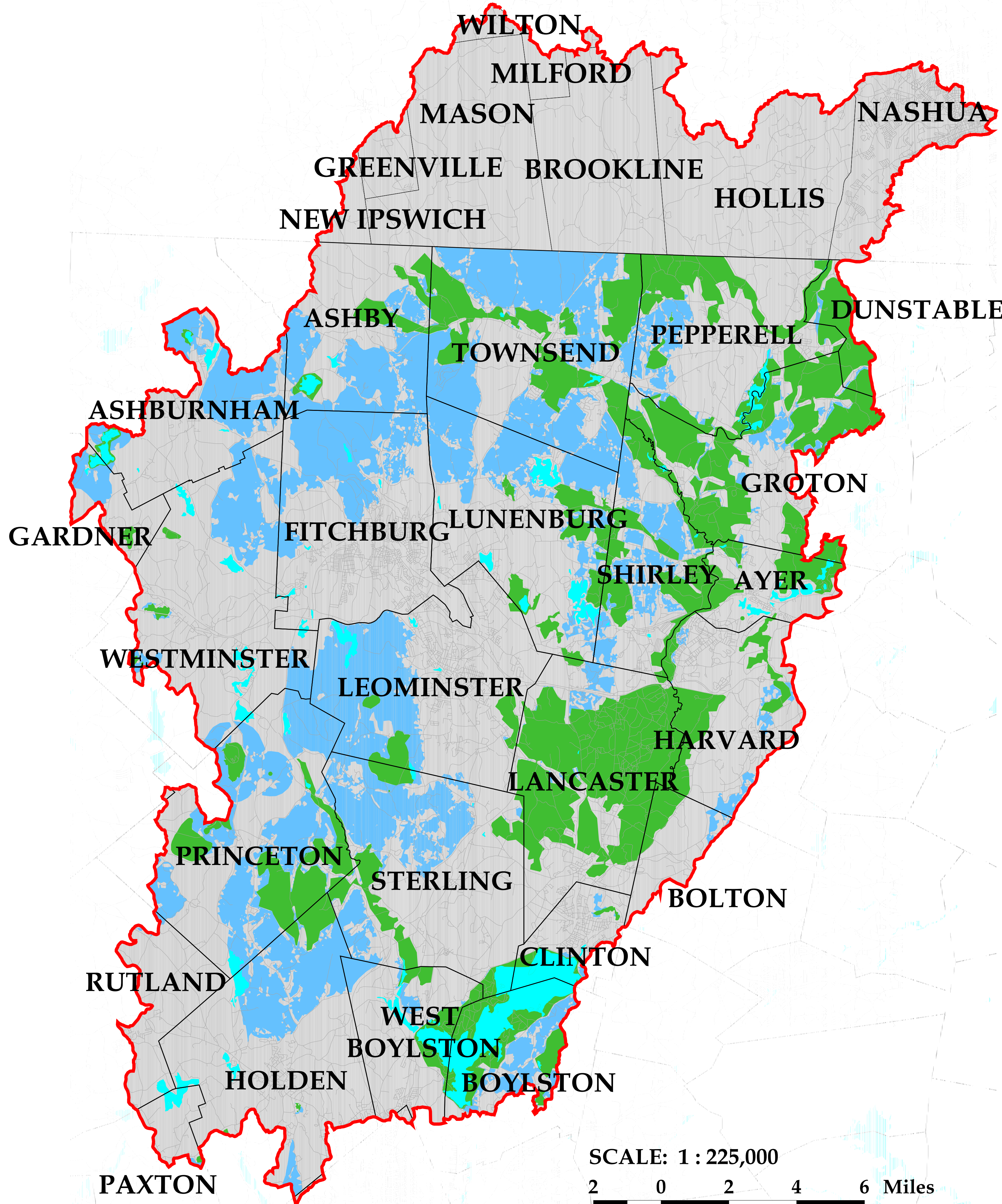
SCALE: 1 : 225,000

4 0 4 Miles

NOTES

Shown here are the locations of the five natural community and wildlife habitat inventories conducted by the Mass Audubon Ecological Extension Service. Site visits were performed in the focal areas shown only if prior permission was granted from private landowners.

FIGURE 3. BioMap Core Areas and Supporting Natural Landscape



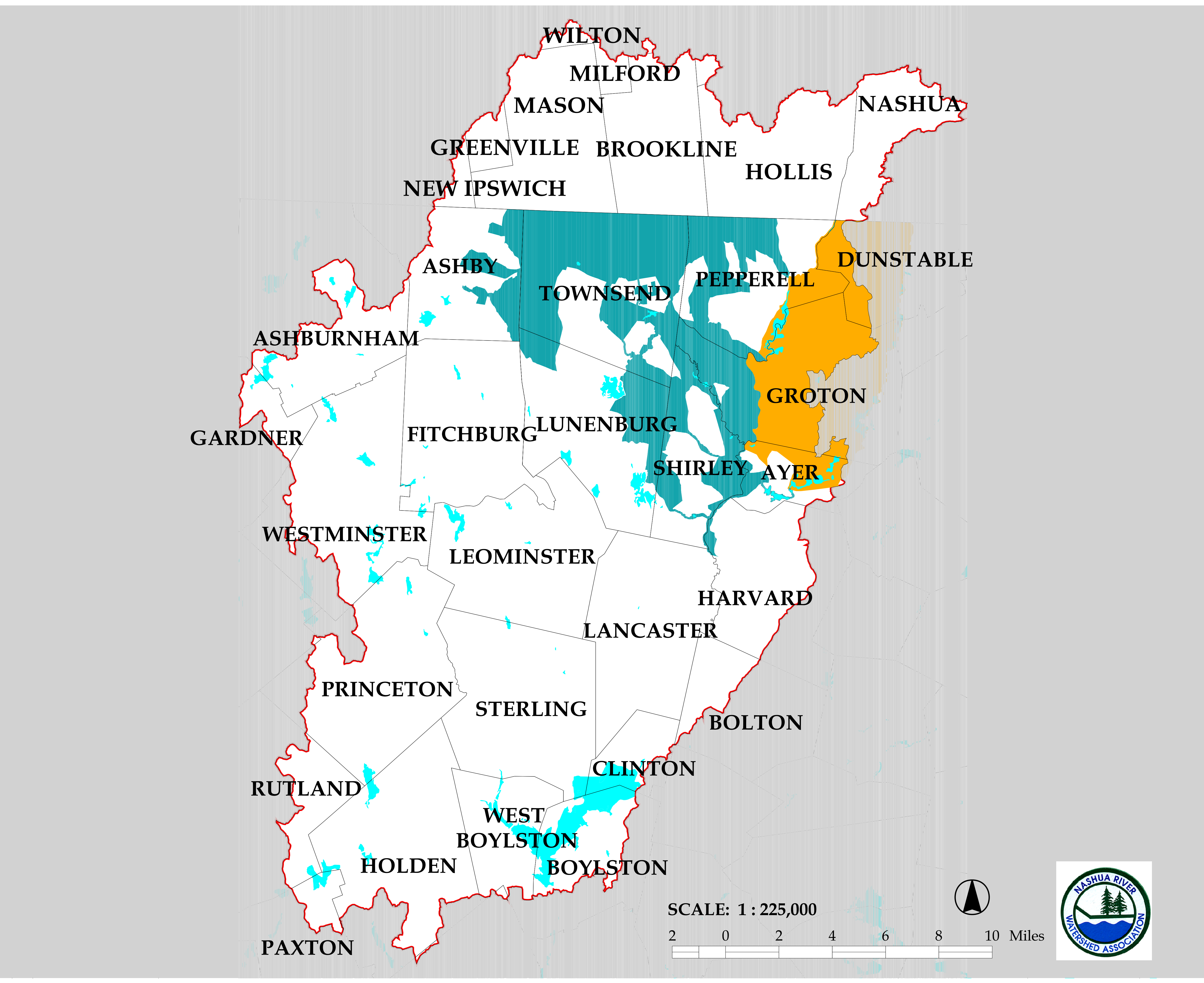
LEGEND

- Nashua River Watershed Boundary
- BioMap Core Areas
- BioMap Supporting Natural Landscape

NOTES

Shown here are the locations of the BioMap core areas and the supporting natural landscape areas as delineated by the Mass Natural Heritage and Endangered Species Program's BioMap project.

FIGURE 4. Squannassit and Petapawag ACECs within the Nashua River watershed



acres of "supporting natural landscape" (or 19.2% of the Massachusetts portion of the watershed).

Figure 3 shows the pattern of the "core habitat" and "supporting natural landscape" within the Nashua River watershed. Note how the "core" areas are clustered in the eastern and northern portions of the watershed. This is due to the more densely developed areas surrounding Fitchburg and Leominster that largely preclude the presence of rare animals. The "supporting" areas, in contrast are located adjacent to the "core" areas and cover much of the central and western portions of the watershed. Once again, there is a gap in the dense areas of Fitchburg and Leominster.

Table 2 shows the acres of "core habitat" and "supporting natural landscape" that are located in each town within the watershed. It also indicates the percentage of each town.

Table 2. Core and supporting landscape in Massachusetts towns of the Nashua River watershed

Town	Acres – Core Area	Percent of town in Core area	Acres – Supporting Natural Landscape	Percent of town in Supporting Natural Landscape
Ashby	1285.9	8.3	5389.0	35.0
Ayer	1714.3	28.2	21.1	0.3
Boylston	5846.2	46.2	3400.5	26.9
Dunstable	6020.5	56.1	1090.7	10.2
Fitchburg	0.0	0.0	5373.8	29.9
Groton	10324.2	47.8	4277.9	19.8
Harvard	2643.9	15.2	2474.5	14.3
Holden	1409.4	6.1	6426.2	27.6
Lancaster	12110.0	67.6	543.3	3.0
Leominster	966.5	5.1	6431.6	33.9
Lunenburg	1904.4	10.7	5561.0	31.3
Pepperell	4310.5	29.1	1582.4	10.7
Princeton	3842.2	16.8	9653.3	42.1
Shirley	3359.8	33.1	3015.3	29.7
Sterling	2445.6	12.1	6057.0	29.9
Townsend	5237.7	24.8	10128.8	47.9
West Boylston	1403.2	15.9	567.2	6.4
Westminster	384.6	1.6	5497.2	23.0
Average	**3622.72**	**23.59**	**4305.04**	**23.44**

This MNHESP project ought to direct citizens interested in inventorying their natural resources or wildlife habitat. More effort should be placed on the "core" areas that are located in a town or area of interest. Once these areas have been inventoried -- using the "supporting natural landscape" layer to help identify the corridors -- future effort can be directed to connections between the core areas.

Aquatic Biodiversity Project

As a complement to the BioMap project, the Aquatic Biodiversity Project will assess and map rare aquatic species and their habitats. The MNHESP anticipates completing this project by July, 2003. The final products of this project will be: an Aquatic Conservation Map, report, and GIS data layers; fact sheets on rare aquatic species; A Field Guide to the Damselflies and Dragonflies of Massachusetts; and The Macroinvertebrates of Massachusetts and Adjoining States. For more information on this program visit the MNHESP website, www.state.ma.us/dfwele/dfw/nhesp/nhaqua.htm.

Section 3.2 - Petapawag and squannassit areas of critical environmental concern (ACEC)

Areas of Critical Environmental Concern (ACECs) are areas that receive special attention because of the unique and significant natural and cultural resources that are present. They are identified and nominated by groups of interested citizens, and are reviewed and designated by the state's Secretary of Environmental Affairs.

The following text describes the newly nominated Petapawag and Squannassit ACECs. The following text was taken from the state's press release concerning these two ACECs.

The Petapawag and Squannassit are premier areas for biodiversity, and include important and large-sized areas of protected open space and conservation lands. The Petapawag area covers about 25,630 acres in five towns, and Squannassit includes about 37,450 acres in nine towns. The two newest ACECs increase the total number of Areas of Critical Concern throughout the Commonwealth from 26 to 28. Their combined acreage increases

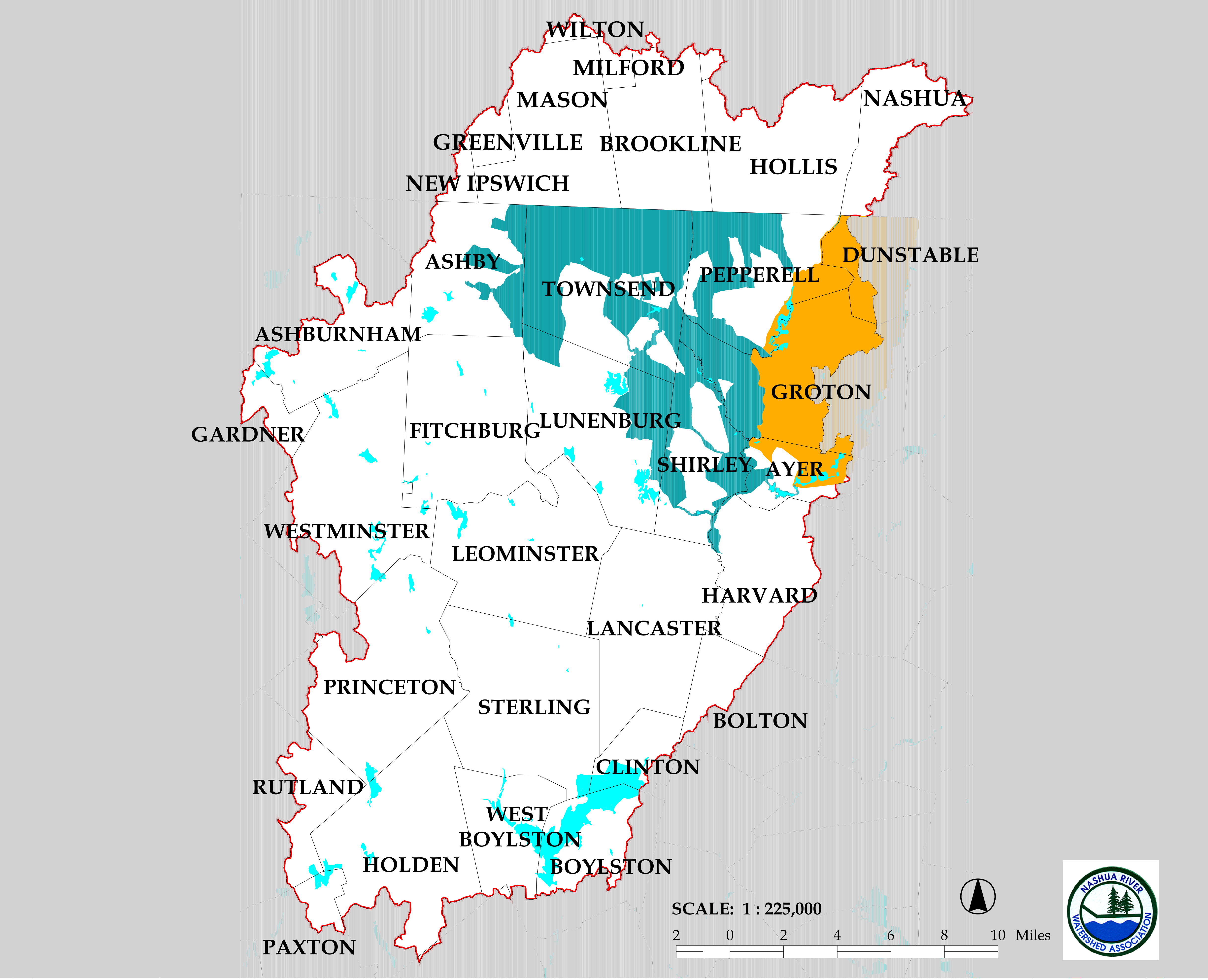


FIGURE 4. Squannassit and Petapawag ACECs within the Nashua River watershed

the overall total from 178,000 acres to 241,000 acres.

“The two new ACECs contain an extraordinarily diverse concentration of highly significant environmental resources,” said Secretary Durand. “The community support for these designations expressed throughout the public review process was strong and unwavering. The ACEC designation will help create an important framework for the long-term preservation and stewardship of these outstanding resources.”

The ACEC designations concluded a public review process that began in late March, when about 190 citizens who live in the 11 towns included in the nominated areas formally submitted the Squannassit and Petapawag ACEC nominations. Secretary Durand accepted both nominations for concurrent review in April. A series of 15 public information meetings were held in the communities during the months of May, June, August, and September.

Secretary Durand conducted public hearings for both nominations in the fall, at which the vast majority of those voicing opinions spoke in favor of the designation. Overall, about 250 written and oral comments were submitted in the course of the review of the nominations, with more than 200 comments in favor. More than 30 town boards and commissions supported the ACEC designations, while none opposed it.

The Petapawag and Squannassit areas are located along and on either side of the Nashua River, from Route 2 in Harvard and Lancaster, north to the New Hampshire state line. The Petapawag ACEC is a contiguous area mostly on the east side of the Nashua River, and includes portions of the towns of Ayer, Dunstable, Groton, Pepperell, and Tyngsboro. The Squannassit ACEC covers a network of river corridors and important uplands mostly on the west side of the Nashua River in portions of the towns of Ashby, Ayer, Groton, Harvard, Lancaster, Lunenburg, Pepperell, Shirley, and Townsend. Portions of Ayer, Groton and Pepperell are located in both ACECs.

In addition, the Petapawag ACEC includes 16 state-listed rare species, and 69 percent of the ACEC has been mapped as Core or Supporting Natural Landscape by the state's BioMap project. These are lands that are crucial for sustaining the most viable populations of rare plants and animals, the best examples of natural communities, and the breadth of biodiversity in the Commonwealth. The Squannassit ACEC includes habitat for 23 state listed rare species, and 79 percent of the ACEC has been included in the BioMap project. Approximately 19,000 acres, or 30 percent of the combined ACECs, is protected open space. Fifteen public water supply wells are also located within the ACECs.

Figure 4 shows the location of the Petapawag and Squannassit ACECs in the Nashua River watershed. The nomination of the two ACECs is a good example of a community-based effort that was based on a thorough inventory of the watershed. The analysis of the natural and cultural resources present in the current ACECs proved crucial to the success of this entire effort.

Section 3.3 - Nashua River watershed focus areas

The Mass Audubon report, "Focus Areas for Wildlife Protection in the Nashua River Watershed" identifies 9 large, 10 medium-sized, and 23 smaller focus areas located within the Nashua River watershed that contain important natural habitat. High quality natural habitat is found in each focus area. While this habitat is important, it is the network of natural habitat created by the combination of all of the focal areas that is truly important. Taken as a whole this network can provide for the requirements of many large animals that would otherwise not persist in any one of the areas alone.

The report stresses that the project was completed on a tight timeline. As a result, the findings should be regarded as a "first cut" at examining the regional pattern of natural habitat located within the watershed. The document urges further refinement of each focal area at the local scale (which – in 5 instances -- was done the following year). Below is a brief description of each of the focus areas that were identified in this analysis. Refer to Figure

1 for the location of each focal area. Altogether, the focus areas include about 50% of the land area of the watershed.

Each of the focus areas was described briefly. By looking at Figure 1 and then reading the descriptions of each focal area, you can very quickly get a good feeling for the types of resources that are present in the watershed. We placed the information on the large, medium, small and riparian focus areas in Appendix III.

Priority Natural Communities

The final section of the Mass Audubon document contains a list of priority natural communities that are presumed to exist within the watershed. Table 3, reproduced from the Mass Audubon document, lists the communities that are either highest priority or high priority. Priority communities are those that are uncommon in the watershed. Their protection would support the goal of representing the full range of natural communities across their natural range of variation.

Table 3: Priority natural communities for protection in the Nashua River Watershed.

Highest Priority	High Priority
Alluvial Atlantic White Cedar Swamp	Acidic Graminoid Fen
Atlantic White Cedar Bog	Alluvial Red Maple Swamp
Black Ash Swamp	Black Oak - Scarlet Oak Forest / Woodland
Black Gum Swamp	Dry Riverside Bluff
Northern Atlantic White Cedar Swamp	Dry, Rich Acidic Oak Forest
Pitch Pine-Scrub Oak Community	High-Terrace Floodplain Forest
Rich, Mesic Forest	Kettlehole Wet Meadow
Sandplain Grassland	Spruce-Fir Boreal Swamp
Small-river Floodplain Forest	Spruce-Tamarack Bog
Spruce-Fir-Northern Hardwood Forest	Wet Meadow

For detailed descriptions of each of these plant community types, refer to the Mass Audubon document referenced in Appendix IV or contact MNHESP and obtain a copy of their "Draft Classification of the Natural Communities of Massachusetts" (Swain and Kearsley, 2001). If any of these communities are located in your area, they should be inventoried and their exact location identified. This type of information can then be included in complete natural resource inventories or habitat assessments.

How to fit your local assessment/inventory into this regional approach

If you or a local citizen's group are interested in conducting local habitat assessments or inventories, the focus areas identified on a regional scale can be a good starting point to orient your efforts. Find out what research or information has already been collected on your area, and then proceed accordingly. If no work exists in your study area, conduct a natural community and wildlife inventory of the area. This will identify any important features (e.g. geological, soil, natural communities) that are present in your area and will provide a record of your research.

If you already have a particular area in mind, find out how it relates to the nearest focal area. If the area is outside of a focal area, determine if there is a linkage between your area and the nearest focal area. How might the two areas be connected?

Section 3.4 - Natural community and wildlife habitat inventories

The Mass Audubon Ecological Extension Service, working with the Nashua River Watershed Association and the Massachusetts Watershed Initiative, conducted natural community and wildlife habitat inventories of five natural areas in the Nashua River watershed: Snake Hill in Ayer and Groton, Townsend Hill in Townsend, Wright Ponds in Ashby and Fitchburg, Whitney Hill/Muddy Pond in Ashburnham and Westminster, and Pine Hill in Lancaster (Collins 2002). The study areas were selected from among the conservation priorities identified in Focus Areas for Wildlife Habitat Protection in the Nashua River Watershed (Collins 2000) discussed at length above (or wherever it ends up).

Each inventory included multiple visits to each site, guided walks with and anecdotal data collected from those familiar with several of the sites, collection of global positioning system (GPS) and digital photographs in the field, compilation of existing geographic information system (GIS) data for each site, and generation and analysis of new GIS data. The conclusions for each of these inventories are summarized below from the individual inventories (Collins 2002).

Snake Hill in Ayer

Snake Hill is a granite dome, located on the Ayer-Groton border, just north of Sandy Pond in Ayer. It is a very important habitat area due to the diversity of natural communities present, its contiguity and size, the amount of undisturbed interior forest it contains, its location relative to a string of large core habitat areas stretching north to New Hampshire, and its demonstrated role as habitat for endangered species, which require isolation for success and are in decline due to loss of habitat.

Townsend Hill in Townsend

Townsend Hill is located in the northwestern corner of Townsend, Massachusetts. Townsend Hill's value as wildlife habitat arises from its combination of habitat elements, the variety of small patch communities within the matrix Mixed Oak forest, its relative lack of disturbance, and its location relative to other large areas of protected and undeveloped lands. The long ledge and ravine feature provides denning sites in rock outcrops and supports a community of plants associated with nutrient-enriched soils. Although most of the soil is well-drained, wetlands found in small depressions on bedrock or impermeable till host a variety of wetland types. The presence of ravens, here near the current limit of their observed range extension south and east within Massachusetts, and the at least occasional presence of moose demonstrate that Townsend Hill is part of a system of large undeveloped areas (almost 20,000 acres) which provide habitat for wide-ranging animals.

Wright Ponds in Ashby/Fitchburg

There are two Wright Ponds, Upper and Lower, that are located close to the border between Ashby and Fitchburg, Massachusetts. The ponds lie in the middle of a large (3,600 acres), little-developed area characterized by a notable diversity of natural communities including extensive mixed oak and pine oak forests with stands of American beech, hemlock swamp, ledges, sandy pond shore, shallow marsh, bog, and permanent and intermittent streams. The southern end, centered on ArnHow Farm, includes extensive open grasslands at a range of elevations, and a dramatic undisturbed ridgeline extensively utilized by wildlife. The Wright Ponds area should be recognized for its significance as a connecting block of little-disturbed land between large areas of protected wildlife habitat. Habitat management efforts might focus on ways to maintain the community diversity through sustainable forestry, agriculture, or other management.

Whitney Hill / Muddy Pond in Ashburnham/Westminster

This area is located on the Westminster / Ashburnham boundary. This area lies within the Worcester Plateau ecoregion and contributes to regional-scale habitat diversity within the Nashua River watershed. Such large undeveloped areas on the western side of the watershed are important for protection of tributary streams and wetlands for habitat and flood prevention. The few roads running through the area are little traveled and present minimal barriers to wildlife movement, although additional development along these roads, and clearing of interior parcels would detract from habitat quality.

Pine Hill in Lancaster

Pine Hill is a low elevation, approximately 500-acre section of Lancaster and Bolton, Massachusetts wedged between Devens South Post to the west and Bolton Flats Wildlife Management Area to the southeast. Pine Hill includes sections of floodplain forest and pitch pine forest, two uncommon natural community types, and is an important habitat connector between Oxbow, Devens South Post, and Bolton Flats. Development of sandy uplands on the site could severely impact the corridor function of this area. Recent heavy clearing and sand mining of the area detracts from its current habitat value, but the sandy barrens could be restored to native grassland and pitch pine woodland.

APPENDICES

Appendix I - Types of Habitat and Natural Resource Inventories

Introduction

The inventories described below are placed into one of three categories: simple, moderate, and complex. In general the simple inventories can be accomplished with little or no background in natural resources disciplines, with little or no funding, and in a short to medium amount of time (3-6 months). Abundant enthusiasm is often sufficient to propel this type of inventory to completion. In contrast, the complex inventories will require a background in natural resources or wildlife ecology disciplines, will almost always require significant funding, and will represent a long term project (1 to multiple years). Such projects can be expensive, costing at a minimum $5,000 - $20,000. Some complex inventories may be completed for little funding, but only if an expert volunteers not only their time, but the necessary hardware and software. The moderate inventories fall somewhere in between the two extremes. Depending on circumstances that are unique to each town or citizen group, the expertise, funding, and time needed will vary.

Within each inventory section below, both terrestrial and aquatic inventory techniques are described. Examples of terrestrial inventories include both wildlife habitat inventories and identification of regional corridors. Aquatic inventories include wetland and stream inventory techniques and briefly describes inventory techniques for intermittent wetland types such as vernal pools. Of course, some inventory techniques will touch on both terrestrial and aquatic resources, such as a comprehensive natural resources inventory.

Table 1 below is a summary of all of the inventory techniques described in the simple, moderate, and complex sections of the guide. If it is appropriate, the supporting agency is listed as well. The table is split into three sections, simple, moderate, and complex. Each section separates the terrestrial and aquatic inventories. If you are looking at the digital version of this document, there are many hyperlinks to appropriate web pages.

Table 1. Simple, Moderate, and Complex Inventories

Agency	Name of Inventory
Simple Inventories	
Terrestrial	
Self	Wildlife Walks / Inventory
Massachusetts Executive Office of Environmental Affairs (EOEA)	Biodiversity Days http://www.state.ma.us/envir/biodays.htm
Self	Bird Inventory – Local bird watching
National Audubon Society (http://www.audubon.org/)	Bird Inventory – Established bird inventories – Christmas Bird Count http://www.audubon.org/bird/cbc/index.html

USGS, Patuxent Wildlife Research Center (http://www.pwrc.usgs.gov/) and the Canadian Wildlife Service, National Wildlife Research Center (http://www.cws-scf.ec.gc.ca/nwrc/cws_nwrc.htm)	Bird Inventory – Established bird inventories – North American Breeding Bird Survey (http://www.mp2-pwrc.usgs.gov/bbs/)
Cornell Laboratory of Ornithology (http://birds.cornell.edu/)	Bird Survey – Established bird inventories – Project Feederwatch (http://birds.cornell.edu/pfw/)
NorthEast Hawk Watch (http://www.battaly.com/nehw/)	Bird Survey – Established bird inventories – Northeast Hawk Watch (http://www.battaly.com/nehw/)
Cornell Laboratory of Ornithology (http://birds.cornell.edu/)	Bird Survey – Established bird inventories – Birds in Forested Landscapes (http://birds.cornell.edu/bfl/)
Self	Plant identification walks using field guides or local experts
New England Wildflower Society (http://www.newfs.org/index.html) and the Greater Worcester Land Trust (http://users.rcn.com/gwlt/gwlt.html)	Plant Inventories – Invasive plants NEWFS - Invasive plant species monitoring (http://www.newfs.org/invasive/invasive.htm) NEWFS – Invasive Plant Atlas of New England (IPANE) (http://invasives.eeb.uconn.edu/ipane/) GWLT – Invasive Plant Species of Massachusetts (http://users.rcn.com/gwlt/invasive.html)
Paul Rezendes Photography and Nature Programs (http://www.paulrezendes.com/) and The New England Naturalist Training Center (http://www.nentc.com/)	Animal inventories
Mass Natural Heritage & Endangered Species Program (MNHESP) (http://www.state.ma.us/dfwele/dfw/nhesp/heritage.htm)	Rare species observation forms (http://www.state.ma.us/dfwele/dfw/nhesp/nhdat.htm)
Aquatic	
Adopt-a-stream (http://www.state.ma.us/dfwele/river/rivAAS_toc.htm)	Riverways Community Report Card
Adopt-a-stream	Shoreline Survey
Adopt-a-stream	Riparian Area Survey
Adopt-a-stream	Stream-walk Survey
USDA-NRCS Water and Climate Center (http://www.wcc.nrcs.usda.gov/)	Stream Visual Assessment Protocol (http://www.wcc.nrcs.usda.gov/water/quality/common/svapfnl.pdf)
USDA-NRCS Water and Climate Center	Water Quality Indicators Guide
New England Regional Monitoring Collaborative (NERMC) (http://www.umass.edu/tei/mwwp/nermc.html)	Rapid Habitat Assessment
New England Regional Monitoring Collaborative (NERMC)	On-site Non-point Source Pollution Evaluation (http://www.umass.edu/tei/mwwp/nermc.html)
Izaak Walton League of America	Level I Wetland Inventry - Handbook for

(http://www.iwla.org/)	Wetlands Conservation and Sustainability (http://www.iwla.org/sos/handbook/)
Massachusetts EOEA (http://www.state.ma.us/envir)	Massachusetts Wetlands Restoration Program (http://www.state.ma.us/envir/mwrp/index.htm)
Mass Natural Heritage & Endangered Species Program (MNHESP) (http://www.state.ma.us/dfwele/dfw/nhesp/heritage.htm)	Certification of Vernal Pools
Moderate Inventories	
Terrestrial	
A variety of agencies will be involved in such an effort	Basic Natural Resources Inventory
This particular methodology was created by the USDA Forest Service (Pacific Northwest Research Station) (http://www.fs.fed.us/pnw)	Bird Survey – Bird count (http://www.fs.fed.us/pnw/bird-populations/)
These methods are described briefly in this document. A systematic search for appropriate links was not conducted.	Methods to census plant populations
These methods are described briefly in this document. A systematic search for appropriate links was not conducted.	Methods to census mammal populations
These methods are described briefly in this document. A systematic search for appropriate links was not conducted.	Methods to census bird populations
These methods are described briefly in this document. A systematic search for appropriate links was not conducted.	Methods to census amphibian and reptile populations
Massachusetts Department of Environmental Management (DEM (http://www.state.ma.us/dem/index.htm)	Forest Stewardship Program (http://www.state.ma.us/dem/programs/forestry/service/steward.htm)
Harvard University (Steinitz et al. 1996)	Visual Preference Survey
Aquatic	
New England Regional Monitoring Collaborative (NERMC) (http://www.umass.edu/tei/mwwp/nermc.html)	Intensive Habitat Assessment
New England Regional Monitoring Collaborative (NERMC)	Streamside Benthic Macroinvertebrate Assessment
Izaak Walton League of America (http://www.iwla.org/)	Level II Wetland Inventory - Handbook for Wetlands Conservation and Sustainability (http://www.iwla.org/sos/handbook/)

Combination Aquatic / Terrestrial Inventories	
Umass Extension (http://www.umass.edu/umext/nrec/index.html)	Critical Habitat Features Checklist and Activities Checklist
Umass Extension	Widlife Habitat Evaluation Field Data Form
Complex Inventories	
Terrestrial	
Mass Audubon Ecological Extension Service (http://www.massaudubon.org/ees.html)	Regional Habitat Assessment and Natural community and wildlife habitat inventories
A variety of agencies will be involved in such an effort	Detailed Natural Resource Inventories
US Fish and Wildlife Service and others familiar with the HEP methodology	Habitat Evaluation Procedure (HEP)
Agencies or organizations with GIS technical capability	GIS-based Analysis of Habitat and Natural Resources - CAPS
Agencies or organizations with GIS technical capability	GIS-based Analysis of Habitat and Natural Resources – Gap Analysis
Aquatic	
Massachusetts Department of Environmental Protection (DEP) (http://www.state.ma.us/dep/dephome.htm)	Watershed-based water quality management program (http://www.state.ma.us/dep/brp/wm/wmhome.htm)
US Environmental Protection Agency (EPA) (http://www.epa.gov/)	Rapid BioAssessment Protocol (RBP) (http://www.epa.gov/bioindicators/html/state/ma-bio.html)
USDA-NRCS Water and Climate Center (http://www.wcc.nrcs.usda.gov/)	Bioassessment protocol of Mass/New Hampshire
New England Regional Monitoring Collaborative (NERMC) (http://www.umass.edu/tei/mwwp/nermc.html)	Intensive Benthic Macroinvertebrate Assessment
Nashua River Watershed Association (NRWA) (http://www.nashuariverwatershed.org/)	Nashua River Watershed Water Quality Monitoring (http://www.nashuariverwatershed.org/)
Izaak Walton League of America (http://www.iwla.org/)	Level III Wetland Inventory - Handbook for Wetlands Conservation and Sustainability (http://www.iwla.org/sos/handbook/)
US Army Corps of Engineers (http://www.usace.army.mil/)	Wetland Evaluation Technique (WET)
Adopt-a-stream (http://www.state.ma.us/dfwele/river/rivAAS_toc.htm)	Riverways Adopt-A-Stream Program Department of Fisheries, Wildlife, and Environmental Law Enforcement
USDA-NRCS	United States Department of Agriculture - Natural Resources Conservation Service
NERMC	New England Regional Monitoring Collaborative

Mass DEP	Massachusetts Department of Environmental Protection
US EPA	United States Environmental Protection Agency

Terrestrial Inventories

A variety of terrestrial inventory techniques are described in this document. In the Simple Inventories section a variety of simple wildlife monitoring skills that citizens can learn are described. Many different bird watching and monitoring programs are described as well as plant and animal identification possibilities. A way to help the Massachusetts Natural Heritage and Endangered Species Program (MNHESP) keep track of threatened and endangered species and natural communities is also described.

In the Moderate Inventories section the information needed to conduct a basic natural resources inventory is described. The Massachusetts DEM Forest Stewardship Program is then described. A method to conduct visual preference surveys is described as well as several relevant documents created by DEM in Massachusetts. Finally, the remainder of this section briefly describes many different census methods that can be used to inventory populations of plant, mammal, bird, reptile, and amphibian species.

Finally, the Complex Inventories section describes the methods that were used to complete some recent habitat assessments conducted by the Mass Audubon Society Ecological Extension. Mass Audubon conducted a Regional Habitat Assessment as well as smaller Natural Community and Wildlife Habitat Inventories. Both of these efforts are described. More complicated studies are also described that can augment the Basic Natural Resources Inventory described in the Moderate section. Finally, analyses to create wildlife habitat models are described that require significant technical expertise.

Aquatic Inventories

Stream Inventories

There are many different well established inventory techniques in the field of stream ecology. These techniques are described by federal and state agencies as well as by extension departments in universities. While there are many small differences from agency to agency in the methods used to implement the techniques, they are on the whole very similar in approach. The techniques available vary from simple to more complex and can be used to assess the health of aquatic systems.

Aquatic habitat assessments -- ranging in complexity from simple to complex-- describe an evaluation of the physical characteristics of a stream or river. Characteristics such as stream flow, depth, width, substrate type, bank stability and erosion potential, instream deposition, and instream cover are measured in order to assess if the stream is suitable for different aquatic species. Identification of the benthic macroinvertebrate species can also be a component of habitat assessments.

Habitat assessments are conducted at reference sites (the least impaired conditions in a region) and impact sites (the sites that might be impacted by human activities). Comparison of the reference sites to the impact sites helps determine the status of different stretches of stream and river habitat. If the habitat quality of a reference site is comparable to an impact site, yet the species composition is significantly different, this might be due to pollution or other human-made disturbance factors. As assessments are made at the same positions on the river over time, it will also be possible to detect significant changes in species or characteristics in the river.

The Simple Inventory section describes several inventories that are primarily visual. The Massachusetts Adopt-a-Stream program has several simple inventories: the Riverways Community Report Card, the Shoreline Survey, the Riparian Area Survey, and the Stream-walk Survey. The US Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS) has its own version of these simple inventories. The Stream Visual Assessment Protocol and the Water Quality Indicators Guide are described. Other groups, such as the New England Regional Monitoring Collaborative (NERMC) also describe and support an array of different techniques available to assess the health of aquatic systems.

The moderate aquatic inventories described require more familiarity with stream macroinvertebrates identification as well as the morphological characteristics of streams. The NERMC offers courses that provide students with experience in Intensive Habitat Assessment techniques, focusing on measurement of the physical characteristics of streams. They also offer instruction in conducting Streamside Benthic Macroinvertebrate Assessments.

Finally, the most complex inventories require considerable expertise in aquatic ecology and complex monitoring techniques. The state and federal aquatic programs are briefly described. Another course offered by the NERMC is described, suitable for those with advanced knowledge of aquatic systems interested in learning how to conduct Intensive Benthic Macroinvertebrate Assessments. The Nashua River Watershed Association Water Quality Monitoring Program has developed a sampling scheme for the rivers within the watershed that is based on the US EPA Bioassessment Protocols established for Volunteers. This level of inventory requires the preparation of a Quality Assurance Project Plan (QAPP) to insure consistent data accuracy and collection techniques.

Wetland Inventories

As with stream inventories there are a variety of wetland inventory techniques and resources available. The Izaak Walton League of America (IWLA) published a "Handbook for Wetlands Conservation and Sustainability" which is a very good source of information for those interested in implementing wetland inventories. The IWLA distinguishes between three levels of inventory. We summarize these three levels, I, II, and III, in the simple, moderate, and complex sections respectively.

There are, however, many other sources of information that can be used. The US EPA, for instance, has recently published "Volunteer Wetland Monitoring: An introduction and resource guide". This booklet provides an introduction to why and how people monitor wetlands and includes a multi-page resource guide to handbooks and manuals that offer detailed information on wetland monitoring for the layperson. While not a methods manual, the guide offers advice on approaching wetland monitoring, most of which is a synthesis of comments received from organizers of wetland monitoring programs across the United States. It is available online at, http://www.epa.gov/owow/wetlands/monitor/volmonitor.html. This document has a resource section that includes an annotated bibliography of many wetland monitoring documents that have been published nationally as well as additional information links to other EPA resources. Many of these resources as well as a variety of other resources are located in Appendix V.

In addition to description of the IWLA techniques, the Simple Inventory section covers the Massachusetts Wetlands Restoration Program as well as the steps to take to inventory and certify vernal pools. In the Complex Inventory section the US Army Corps of Engineers Wetland Evaluation Technique (WET) is briefly described.

Simple Inventories

The simple inventories described below can be accomplished with little or no background in natural resources, with little or no funding, and in a short to medium amount of time. The key ingredient in this type of inventory is volunteer interest and enthusiasm.

Terrestrial Inventories

Simple terrestrial inventories should be used to gain basic information about wildlife habitat, wildlife species, or natural resources. Simple terrestrial inventories are a great way to give volunteers with limited time a basic understanding of the natural environment in which they live. Most of the inventories described below provide not only educational opportunities but also some basic information on terrestrial habitat and species.

Wildlife Walks/Inventories

If your town does not have an active group of citizens interested in natural resource issues, wildlife walks are a great way to begin to assemble a group of active town volunteers. There are many different themes around which a walk can be organized (bird inventories, plant identification, animal inventories, etc.). The Biodiversity Days annual wildlife inventory, sponsored by the Massachusetts Executive Office of Environmental Affairs (EOEA), is a fantastic example of how local wildlife inventories can contribute to local knowledge of wildlife species. This program is described below. It is important to find a local citizen or person that is knowledgeable about topics related to your walk. The NRWA is a good source of local wildlife experts (See Appendix V for contact information). Once you have acquired a leader for your expedition, advertise the time and date of the walk through traditional local advertising means (newspaper, local flyers, email, etc). Mention basic supplies that people should bring such as water, appropriate clothes, a snack, and sunscreen. The leaders of such expeditions should bring basic first aid equipment.

Field guides are a wonderful source of information on the wildlife communities and species that exist in the Nashua River watershed. Appendix IV lists many popular field guides that will be useful.

One simple system that can be used to track local information on terrestrial species and communities of concern is to take the USGS 1:24,000 quadrangle maps into the field with you when going on nature walks or doing simple inventories. Mark down the areas where you have seen rare species or natural resources that you think are noteworthy. Over time, these paper maps will become a source of information on the natural world in your area of interest. This type of system was used for a period of years at the River Resource Center.

GIS and GPS (see glossary) technology, while moderately complicated, is a great way to monitor the resources in your town. In a similar way to the paper based monitoring system described above, a few dedicated volunteers can set up a very useful local GIS database with many different useful pieces of information on terrestrial species and communities.

General inventories

Biodiversity Days

Biodiversity Days is a program that was initiated in 2000 by the Massachusetts EOEA. Early each summer, interested citizens from around the state will gather locally to inventory as many species as possible in chosen study areas. All of the information that is collected is then integrated into the "Visible species of Massachusetts" biodiversity database that is maintained by the EOEA. For more information about this program visit the Biodiversity Days website (http://www.state.ma.us/envir/biodays.htm) , or contact Mary Marro (education@nashuariverwatershed.org), the director of the Nashua River Watershed Association Environmental Education program. This program is a great way to educate children and citizens about biodiversity and the natural world in which they live.

Bird inventories

Bird watching is a good way to introduce interested volunteers to wildlife. When just beginning, it is suggested that volunteers accompany more experienced birders for a bird-watching expedition. As volunteers gain more experience and ability to recognize birds, both by sight and sound, they can conduct local bird counts at various times throughout the year to inventory the status of local bird populations. If such counts are continued for multiple years, local population trends can be identified in bird populations. Some birds serve as indicator species for specific types of habitat.

Local Bird watching

Organizing a bird watch is a very simple way to get citizens involved in inventory of wildlife species. As volunteers gain more experience, more systematic counts can be taken of bird species and more responsibility can be delegated to volunteers.

Equipment: The most important piece of equipment is a good pair of binoculars. There are many different types available today. If you are interested in purchasing a pair, contact an experienced birder and ask for a recommendation, or contact the Mass Audubon Society (see Appendix V).

Serious birders will usually have both binoculars and a more powerful magnification instrument such as a spotting scope. The additional power of the spotting scope makes a tripod necessary or a car window mount, in order to stabilize the field of view.

Field guides are a crucial addition to any bird watching expedition. Most field guides have color plates that aid in easy identification of bird species by sight. See Appendix IV for a list of popular field guides useful when bird watching.

Birds can be identified by the sound of their bird calls (vocalizations) as well as by sight. More experienced birders can identify species by either of these methods. Audio recordings of bird species are available that aid in learning many bird songs (see Appendix IV for information). Recordings of birds are available from some Public Libraries (including Groton) or through interlibrary loan.

Established Bird Inventories

There are a variety of existing programs for monitoring bird populations. The Cornell Laboratory of Ornithology (http://birds.cornell.edu/) supports many of these monitoring programs and has a good website describing these many programs.

Christmas Bird Count

The Christmas bird count (CBC) is the longest running bird inventory effort in ornithology. Information on early winter bird populations has been collected in areas throughout the entire United States since the first CBC on December 25, 1900. The primary objective of the CBC is to monitor the distribution and status of birds in the Western Hemisphere.

The CBC takes place between December 14th and January 5th of each year. Interested citizens can choose the designated CBC 15 mile circle in which they would like to inventory bird populations. The efforts in each designated circle are organized by a compiler that must be contacted if you are to participate in the CBC. Beginners and seasoned ornithologists are welcome to participate in these inventories.

The information collected shows how bird populations have been changing since the turn of the century. The information is extremely useful for conservation purposes as well. Local trends in bird populations can be indicators of environmental change that is caused by humans or other factors.

For more detailed information on the CBC in your area, contact Mass Audubon (see Appendix V) or visit the CBC web site located at http://www.audubon.org/bird/cbc/index.html .

North American Breeding Bird Survey

The North American Breeding Bird Survey (http://www.mp2-pwrc.usgs.gov/bbs/) (BBS) is a long-term, large-scale, international bird monitoring program. It was begun in 1966 to track the status and distribution of bird populations in North America. This program is jointly coordinated by the Patuxent Wildlife Research Center (http://www.pwrc.usgs.gov/) and the Canadian Wildlife Service, National Wildlife Research Center

(http://www.cws-scf.ec.gc.ca/nwrc/cws_nwrc.htm).

In order to participate in the BBS you must meet the following requirements for participation (taken from the BBS website):

- Access to suitable transportation to complete an inventory.
- Good hearing and eyesight
- The ability to identify all breeding birds in the area by sight and sound. Knowledge of bird songs is extremely important, because most birds counted on these inventories are singing males
- New BBS participants must also successfully complete a brief training review before their data will be used in any BBS analyses. The training program is available from the national BBS offices and the state, provincial, and territorial coordinators.

The BBS is collected at the height of the breeding season. Participants are assigned breeding bird routes that are 24.5 miles long. Bird counts must be conducted every half a mile along the assigned route using an established procedure. Massachusetts and New Hampshire each have a contact for the BBS (see Appendix V).

Project FeederWatch

Project FeederWatch (http://birds.cornell.edu/pfw/) works with volunteers to sample residential and park bird feeding stations throughout the winter at regular bi-weekly intervals. While the Christmas Bird Count and the North American Breeding Bird Survey take only one data point during the year, Project FeederWatch collects multiple sitings each winter, allowing for creation of abundance indexes for many species.

North East Hawk Watch

North East Hawk Watch (http://www.battaly.com/nehw/) is a not-for-profit organization that seeks to increase awareness, appreciation, and protection of New England's raptor species. See Appendix V for contacts for the Massachusetts and New Hampshire Hawk Watch programs. Mt Wachusett (Princeton) and Mt. Watatic (Ashby) are two area lookouts that people visit to see hawks migrating. There are many other lookouts where interested hawk-watchers can see hawks migrating through Massachusetts and New Hampshire in the Fall (mid-September - November) and Spring (2nd half of April - 2nd half of May).

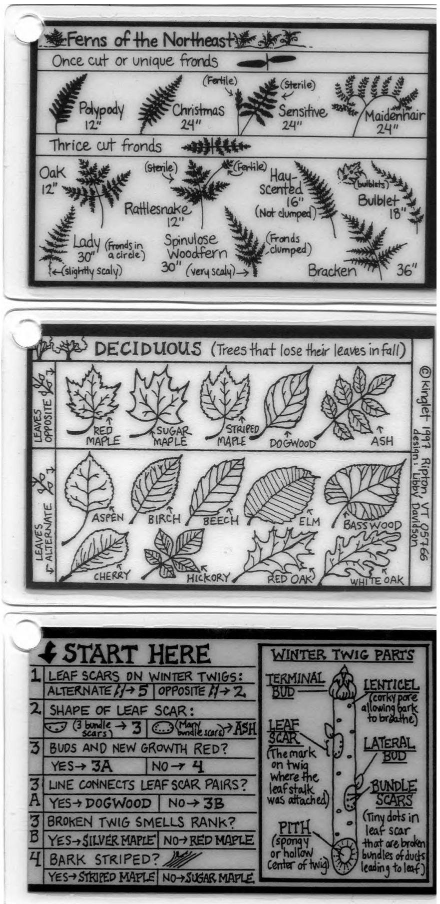
Birds in Forested Landscapes

The Birds in Forested Landscape (http://birds.cornell.edu/bfl/) Citizen Science program helps participants choose study sites in forests of various sizes. They then record the presence or absence of certain focus species on at least two visits by recording bird vocalizations. Participants also look for indicators of successful breeding as well as recording several landscape characteristics. This is a good example of a program, if done over the long-term that would allow volunteers to gather information about the status of local bird populations.

Plant inventories

Plant identification is another wonderful way to introduce citizens to the variety of plants and plant communities that are present in the Nashua River watershed. Throughout spring, summer, and fall a parade of different flowering plants bloom. With enough experience, study of plant communities allow naturalists to piece together the history of the landscape from pre-settlement times to the present.

See Appendix IV for a list of the plant and community guides that exist for New England.



Examples of cards one can use to identify plant species

Field guides with color plates or detailed botanical drawings are very useful to aid in identification of plants. Plant identification keys are set up differently but are generally more useful when learning how to identify plants. Typically, a plant key will walk you through a set of characteristics as you try to identify a plant, eventually eliminating all possibilities except one. Very simple examples of plant keys are shown below.

Invasive plant species monitoring

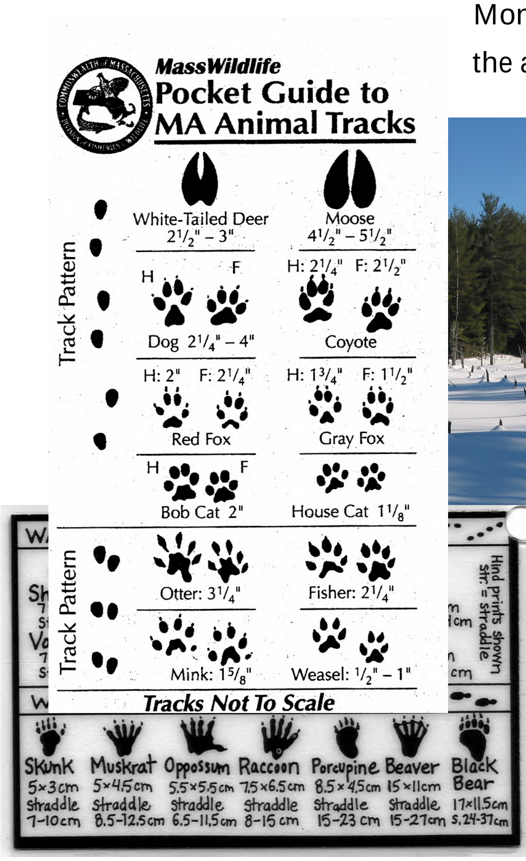
There are over 60 plant species in Massachusetts that are invasive species. Invasive plants were introduced into the watershed either by accident or sometimes intentionally for reasons such as erosion control. Due to the lack of diseases and predators that are present in their new habitat, such species will often have a competitive advantage over native plant species. Invasive plant species often can reproduce quickly, produce seeds throughout the growing season, spread quickly, are not affected by native disease or pests, and are difficult to remove.

One simple type of inventory that local groups can do is an inventory of the invasive species in their town. Lists of the invasive plant species can be found in the books that are listed in Appendix IV, or by visiting the following two websites. The Greater Worcester Land Trust web site lists all of the plant species and briefly describes the problem (http://www.ultranet.com/~gwlt/invasive.html). The New England Wildflower Society is probably the best source of information on invasive species control techniques in Massachusetts. They have a web page devoted to the control of invasive plant species (http://www.newfs.org/invasive/invasive.htm). Once identified actions can be taken to attempt to control the plant species if that is deemed desirable.

The NEWFS is recruiting volunteers to participate in the Invasive Plant Atlas of New England. It is a joint effort between the NEWFS, Silvio O. Conte National Fish and Wildlife Refuge, and the University of Connecticut. The effort was started to track the distribution and spread of over 100 invasive plant species throughout New England. A series of training programs are being offered to interested citizens where they will learn to fill out data sheets, create herbarium specimens, identify invasive plants and map populations of invasive plants. This effort is planned to continue at least through 2004. More information on this project and the inventory can be found on the NEWFS web site (www.newfs.org) or on the web site of the Invasive Plant Atlas of New England (http://invasives.eeb.uconn.edu/ipane/). An organization can contact the Invasive Plant Survey if there is a specific parcel that they want inventoried. For more information see Appendix V for the contact information.

The US Geological Survey (USGS) reports on sources of funding related to invasive species management. For more information visit the website, http://invasivespecies.gov/toolkit/grants.shtml.

Animal inventories



River otter tracks in winter as well as samples of cards that can be used to aid in identification of animal tracks

Monitoring animals other than birds is yet another way to build the appreciation of the outdoors in your community. However, larger animals, unlike birds and plants, are more elusive. As a result, very different techniques are employed when trying to monitor animal populations. Often, we must look for what animals left behind rather than trying to look for the animal itself.

Learning to distinguish between the tracks of different animals is one of the most effective ways to detect animals when they cannot be found. The tracks below show the commonly found tracks.

In addition to tracking animals, we can often learn of animals through the scat that they leave behind. In more rigorous studies, scat can be used to study the feeding habits of particular animals.

If you are interested in improving your tracking skills, Paul Rezendes and many others such as John McCarter and David Kay conduct courses in tracking throughout the year. To learn more about Paul Rezendes Photography and Nature Programs visit the website www.paulrezendes.com. The New England Naturalist Training Center also offers courses that will improve your tracking abilities (www.nentc.com). There are other resources available in the region that have not been listed here. See Appendix IV for some books that may be of use when learning how to track.

Rare plant/animal identification

With enough experience in plant and animal identification, there are some simple ways to help the State of Massachusetts track the rare plants and animals that live in the watershed. The Massachusetts Natural Heritage and Endangered Species Program (MNHESP) has a variety of rare plant and animal observation forms that citizens can fill out and send to MNHESP. These forms need to be supported by additional materials such as photos, maps, video, and audio tapes. These forms are included in Appendix XII and can also be accessed by the internet (http://www.state.ma.us/dfwele/dfw/nhesp/nhdat.htm). Take note of the official state rare species list to find out which species are officially threatened, endangered, or of special concern. (See Appendix VI for the state definition of endangered, threatened, and special concern.) MNHESP also tracks listed species that have been seen in each of the Massachusetts towns. These lists can help to jump start your inventorying efforts.

Aquatic Inventories

There are a variety of actions that can be taken to help inventory and assess the health of local aquatic resources. The sections below describe these methods. The Massachusetts Riverways Adopt-A-Stream Program is first described, along with several of their stream inventory programs. The Natural Resources Conservation Service (NRCS) has also developed a stream assessment protocol that is described. The New England Regional Monitoring Collaborative (NERMC) offers courses in simple inventory techniques. Two of these inventory techniques are described as well as the courses offered to train people in these techniques. The Izaak Walton League of America level I wetland inventory is then described as well as the Massachusetts Wetlands Restoration Program. Finally, the steps to identify and certify vernal pools are outlined.

Adopt-A-Stream Program

The Adopt-A-Stream Program in the Department of Fisheries, Wildlife, and Environmental Law Enforcement was established in 1987. Since then, the program has sought to help local people get involved in the protection of rivers and related open space issues. The Adopt-A-Stream Workbook, published in 1992 describes this program as well as many actions that can be taken by interested citizens. More information on this program can also be found on their website, http://www.state.ma.us/dfwele/river/rivAAS_toc.htm. The Adopt-A-Stream program has also more recently published the "Stream Team Leader's Manual". This document provides guidance for local citizens that are interested in forming "stream teams" to protect and restore local streams. The manual can be downloaded in pdf format from the following website, http://www.state.ma.us/dfwele/river/rivAAS_pubs.htm. The program has created data sheets for several types of inventory that citizens can undertake. These inventories are described below.

Riverways Community Report Card

One of the simple actions that can be taken to begin to inventory the aquatic resources in your town or area is to complete a Riverways Community Report Card. The report card is included in the Adopt-A-Stream Workbook.

The report card helps local officials and citizens determine how much work is needed to protect local aquatic resources. It represents a first step towards inventorying the aquatic resources in your community, dealing primarily with the current types of physical protection and legislative protection afforded the rivers and streams in the community. The report card is split into two sections. The first section is devoted to an assessment of the land adjacent to the river while the second section considers the river's water quantity and quality. See Appendix XII for the Riverways Community Report Card.

Answer the questions in the Report Card, scoring the answers as directed by the instructions. When completed, add up the scores and then rate the protection for riparian lands that the community provides for its riverways.

Shoreline Survey and Riparian Area Survey

Another basic inventory that can be performed is the Shoreline Survey. The Shoreline Survey is designed to provide a basic inventory for specific segments of the river and streams in your community. See Appendix XII for a copy of the Shoreline Survey. Several reaches within the Nashua River watershed have been surveyed by stream teams (Nashua River in Clinton, Nashua river in Fitchburg, Nashua River in Pepperel, Philips Brook, Catecunamaug Brook, Unkety Brook, and the Nissitissit River). Visit the following web page to see the online surveys, http://www.state.ma.us/dfwele/river/rivnashua.htm. The NRWA can be contacted for information about these surveys.

Examine the major stretches of river and stream that run through your community on a USGS topographic map and divide them up into manageable stretches of river (e.g. half a mile) that can be inventoried. The questions that are asked are basic and can be completed by those with little or no experience. As always, the appropriate safety precautions should be taken when conducting the inventories (See appendix VI).

The Riparian Area Survey is a bit more involved than the Shoreline Survey and will take more time to complete. The inventory focuses on both the areas immediately next to the stream (within 15 ft of flow) and the important "riparian" area that is adjacent to the stream (this area varies in width from 100 ft up to 500 ft from the stream). Groups that have identified areas that would benefit from a riparian restoration project (e.g. heavily eroded sections, sections where illegal dumping is apparent) should use the Riparian area survey to document the conditions. The ultimate goal of the inventory is to direct efforts towards restoration. After the Riparian Area Survey is completed, additional work will be required to create an action plan that will hopefully lead to riparian restoration of the stream segment.

The NRCS Stream Visual Assessment Protocol and the Water Quality Indicators Guide

This protocol is very similar to the inventories that are supported by the Adopt-A-Stream program. There is no one definitive inventory methodology that must be used for aquatic resources. That is why we are describing several methods that are very similar. The protocol is a simple way to assess a stream's condition based on a visual evaluation of its physical characteristics. It can be used by people that have little biological or hydrological training. It is designed so that the person implementing the protocol can talk and interview private landowners that have aquatic resources on their properties. One or more sections of the stream need to be inventoried and the results recorded on a worksheet. The results are tallied and then described to the landowner.

For more information on this protocol please refer to the PDF document that is available on the web (http://www.wcc.nrcs.usda.gov/water/quality/frame/wqam/Guidance_Documents/guidance_documents.html). The Natural Resource Conservation Service (NRCS) protocol is the first level of complexity in a four part hierarchy of assessment protocols. Tier 2 is the NRCS Water Quality Indicators Guide, Tier 3 is the NRCS Stream Ecological Assessment Field Handbook, and Tier 4 is the Intensive Bioassessment Protocol that is implemented in Massachusetts and New Hampshire (Newton et al. 1998). The tier 3 protocol is briefly described in the Moderate Inventories section. The tier 4 protocol is available from the NRWA Resource Center.

The Water Quality Indicators Guide is similar to the Stream Visual Assessment Protocol. It was published in 1989 and contains worksheets that can be used to assess visual conditions and detect indications of water quality problems. Copies are no longer available through NRCS but may be ordered from the Terrene Institute (http://www.terrene.org/index.htm) at 703-548-5473.

New England Regional Monitoring Collaborative

The NERMC offers various courses in aquatic inventory techniques. The techniques described here are simple. There are other courses offered by NERMC described in the Moderate Inventories section of the document.

Rapid Habitat Assessment is a methodology that uses primarily visual estimates of the physical characteristics of a stream in order to determine the overall quality of the habitat for benthic macroinvertebrates. Habitat assessments are conducted at references sites (areas that are least-impaired) and compared to impact sites (areas affected by human activities).

The NERMC conducts training in rapid assessment techniques. Participants are taught the basic importance of each of the habitat characteristics, how to visually estimate these characteristics in the field, how to score the results, and how to interpret the comparison to the reference site.

NERMC also offers training in On-site Non-point Source Pollution (NPS) Evaluation. This methodology teaches participants to evaluate the seriousness of potential pollution, erosion, sedimentation and runoff problems for a stream. There are a variety of site worksheets that have been developed for different associated land use activities (agricultural, logging, construction, shoreline areas, residential developments, roads, parking lots, and boat ramps). Training covers interpretation of topographic maps, soil maps, and aerial photographs, watershed delineation, and shoreland inventories. The major emphasis is on watershed processes, land use activities that generate nonpoint source pollution, the visual indicators of pollution, and the best management practices (BMPs) that can be implemented to mitigate for pollution.

For information on the courses described above, contact the NERMC at (413) 545 5532 or visit the website http://www.umass.edu/tei/mwwp/nermc.html.

Wetlands

Level I inventory

All of the questions below are reasons to conduct a local wetland inventory: Do you know if the wetlands in your town are healthy? What ecosystem services (e.g. water purification, water storage) are provided by the wetlands in your town? How many acres of wetlands are there in your town? What percentage of the area's wetlands have already been delineated by local conservation commissions? Do you know how the wetlands have changed in your town in recent history (e.g. beaver dams, human alteration)?

Assembling a group of volunteers to answer these questions will create a group of dedicated citizens that are strong advocates for the protection of wetlands. Volunteers may undertake any of the following tasks:

- Educate selves and others
- Start a community wetlands stewardship program
- Inventory wetland areas
- Monitor wetlands for unauthorized activities – the conservation commission is officially responsible for wetland monitoring. However, citizens aware of the wetlands in a town will learn to notice unauthorized activity that can be reported to the conservation commissions.
- Identify critical wetlands for potential acquisition

- Identify areas where wetlands could be restored

The Izaak Walton League of America distinguishes between three levels of wetland monitoring. Level I addresses the basic issues of where the wetlands are that need to be monitored, and collects background information on these sites. Level II monitoring requires a significant amount of time and resources from the interested citizens. Information about vegetation, soils, hydrology, and animals present are collected through use of transects, standard operating procedures, and repeated collections. Level III monitoring is an intensive undertaking that requires technical expertise and additional funding and time. An exercise such as determining why local amphibian populations are decreasing and how to rehabilitate them would be a level III undertaking.

In this section of the document, we summarize the level I monitoring program described by the Izaak Walton League of America.

If there is not an established wetland monitoring system in your town, a level I program is an important step. To see the four data sheets used by the Izaak Walton League of America please visit the Nashua River Watershed Association River Resource Center or order the "Handbook for Wetlands Conservation and Sustainability" from IWLA. The forms are: "Wetland Background Information ", "Seasonal Field Observations ", "Photographic Record ", and "Human Impact Survey ". Refer to the "Handbook for Wetlands Conservation and Sustainability" written by the IWLA (http://www.iwla.org/sos/handbook/. See Appendix IV for reference) for a complete description of how to implement a level I monitoring program. Once the level I forms are filled out for the wetlands in your community, you should have the following sets of information:

- A brief description of the site and the reasons that monitoring was initiated.
- Contact information for the monitoring group as well as any private landowners that were involved in the monitoring or on whose land the effort was conducted.
- Maps:
- USGS Topographic map with watershed boundaries marked
- National Wetland Inventory Map
- Map showing location of wetland and how to get there
- Local soil inventory map or local hydric soils list
- A master monitoring map showing point locations, wildlife sightings, vegetation communities, and other related pieces of information.

The Massachusetts Wetlands Restoration Program

In 1994 the Massachusetts Wetlands Restoration Program (MWRP) was established within the Massachusetts EOEA. The GROWetlands Initiative was founded within this program in order to support locally initiated wetland restoration projects. The initiative encourages local groups to become the sponsors of wetland restoration efforts.

The MWRP cautions that this type of project can become involved and require significant amount of time. However, the initial investment of time needed can be taken on by a small group of interested citizens.

The GROWetlands Initiative defines wetland restoration as, "the act, process, or result of returning a wetland or a former wetland to a close approximation of its condition prior to disturbance".

The MWRP lists the following characteristics that will make it more likely a wetland restoration projects is funded:

- The potential project area should be greater than 1/2 acre in size
- The area is located on town, state, or other public land or is under long-term protection if privately owned.
- The public and/or private landowner supports this project
- The restoration work, if implemented, will not result in negative impacts on adjacent land uses and property.
- The project fits nicely into the criteria established for federal funding of restoration projects.
- The area is in a fairly prominent location so it can be used as a classroom in the future or can be noticed.
- The proposed restoration can realistically be performed (doesn't involve tearing up existing infrastructure) and will likely result in the desired results (e.g. Phragmites can really be controlled in the area)

If you are aware of a site that possesses the above characteristics, it may be worthwhile to become a project sponsor and initiate a GROWetlands Project. Call MWRP for a preliminary assessment of the potential wetland restoration project. Prior to contacting MWRP try to determine which of the above characteristics apply to the area.For more detail on the Massachusetts Wetland Restoration Program and the GROWetlands initiative visit the website www.state.ma.us/envir/mwrp/index.htm. Please see Appendix V for additional contact information.

Certification of vernal pools

General Information

Vernal pools are technically defined as "temporary ponds that fill up with water in the spring as a result of snowmelt, spring rains, and / or elevated groundwater tables." Contrast this with an ephemeral pond which will "retain water only for a short length of time, from a day or two to a week." For some wetland experts it is crucial to maintain the distinctions between these different habitat types.

However, for the purposes of most citizen groups, we need to consider vernal pool habitat as defined by the state of Massachusetts.

- The Natural Heritage and Endangered Species Program defines the term "vernal pool" as "any temporary pond that serves as important wildlife habitat, regardless of size, location, wetland regulatory status, or season of filling."
- The Massachusetts Surface Water Quality Standards define "vernal pools" as those pools "that have been certified by the Massachusetts Natural Heritage and Endangered Species Program."
- Yet another definition, that adopted by the Wetlands Protection Act Regulations, says "vernal pool habitat" "includes not only the vernal pool itself but also an area up to 100 feet wide surrounding the pool."

It is important to keep these slightly different definitions in mind as you are inventorying local vernal pools.

Why are vernal pools important?

These seasonal habitats are important because they provide important breeding habitat for many species of amphibians, reptiles, and invertebrates. In the absence of this habitat, these species will be locally extirpated.

Many different species depend on vernal pools during all or some of their life cycle. Obligate vernal pool species are those that depend on vernal pool habitat for their survival. Facultative species are those that, while found in the vernal pools, are not entirely dependent on them. "State-listed" species are found in both of these categories. If vernal pools are destroyed or drained, the obligate species will not be able to reproduce.

Why do we need to certify vernal pools?

There are several pieces of Massachusetts legislation that are relevant to protection of vernal pools in Massachusetts. In the cases of the Wetlands Protection Act and the Surface Water Quality Standards, certification of a vernal pool will increase its state-level? protection due to legislative. If a federally or state listed threatened or endangered species is identified therein, the vernal pool would? also be protected. Local bylaws may also protect vernal pools . For more information on the protection provided by legislation refer to the Mass Audubon Society document, “Certified: A citizen’s step-by-step guide to protecting vernal pools" (See references in Appendix IV).

Importance of local involvement in the process

Although certified vernal pools are technically protected by the Surface Water Quality Standards, there is no automatic mechanism that informs the regulating authorities of proposals to discharge or alter vernal pools. For this reason, it is often vigilant citizens that will notify the authorities if a proposed project might damage a (suspected or certified) vernal pool.

How to identify and certify vernal pools

In order to certify a vernal pool, proof must be given to the MNHESP so it can then certify the vernal pool. The easiest way to certify a vernal pool is to prove that the "obligate" vernal pool species described above are present. Alternatively, if no proof of "obligate" species presence can be found, then it must be proved that the pool : 1) is located in a closed depression; 2) dries up for part of the year (to prove that no fish are present); and 3) that other facultative vernal pool species are present. If no obligate species are found, photos can be used to prove that the pool is not present all year long. It will be necessary to make multiple trips to the site to document such conditions.

Additional information

For additional information, visit the MNHESP program's website (http://www.state.ma.us/dfwele/dfw/nhesp/nhdat.htm) to download copies of the forms that are also found in Appendix XII of this document. The MNHESP also maintains two GIS data layers related to vernal pools. One shows those vernal pools that are already certified and another layer shows potential vernal pools that were identified using aerial photographs. The former identifies a small number of sites while the latter indicates many more sites (which await certification). To obtain these GIS data layers contact MassGIS or download the layers from their website yourself (http://www.state.ma.us/mgis/database.htm).

Moderate inventories

The inventories described below require moderate to high levels of technical expertise, significant amounts of time, and/or small to medium amounts of funding and other resources most of which can be accomplished by interested citizens. In some cases, citizens will have to learn specific collection methodologies or pieces of software in order to complete the inventory.

Terrestrial Inventories

Basic Natural Resources Inventory

Natural resource inventories are usually found as a section of a municipality's master planning document and will be comprised of a set of maps with brief descriptions.

It makes sense to compile natural resource inventoriesusing Geographic Information Systems (GIS) .

The following layers are typically available from state GIS data sets. In New Hampshire, the GRANIT (Geographically Referenced Analysis and Information Transfer) GIS network is a large statewide database that contains most of the natural resource layers needed (http://www.granit.sr.unh.edu). The Massachusetts Geographic Information System (MASSGIS) database contains most of the natural resources layers needed as well (http://www.state.ma.us/mgis/massgis.htm). A simple inventory document can be compiled if each of these data layers is depicted as a map using GIS software.

Base map

The base map contains the basic information that will allow users of the maps to orient themselves. Usually many different layers of information are displayed on the base map. All subsequent maps will contain most of the data layers included in the base map for orientation purposes. The data layers usually placed on a base map are:

1) Community political boundaries
2) Study area boundary (Usually a buffer of at least one mile is included around the study area. This insures that a context area around the town or study area is included in each map that is produced.)
3) Transportation (roads, railroads, and airports)
4) Utility networks (electric, gas, etc.)
5) Hydrology (streams, rivers, lakes, and ponds)
6) Topography (If contour lines are used to display topography, it is recommended that a separate map be reproduced. Presence of contour lines along with the above data layers will produce a map that is confusing. However, use of hillshade to depict topography allows the presence of the other data layers without too much visual confusion of the map.) Use of hillshade within ArcView GIS requires the purchase of ArcView Spatial Analyst software.
7) Aerial photos - MASSGIS has compiled black and white and color aerial photographs for the entire state at a resolution of 1 meter. These image files can be downloaded and used for specific towns or study areas. Those not accustomed to viewing maps can usually relate very easily to aerial photos and for this reason, this data layer can be very useful. In addition to the photos, one can obtain USGS 7.5 minute series topographic quadrangles from MassGIS

Geology

Geological descriptions of a town or study area are useful. It is often difficult to obtain geology maps that are accurate enough for use on a municipal-wide level in which case, a text description of the geological resources may suffice for a basic natural resources inventory.

When researching the geology of an area, try to find information on the bedrock geology of the area as well as the surficial geology. Bedrock geology refers to the underlying rock formations that lie below the soil and surficial geological deposits. The type of bedrock present (i.e.: “sweet” limestone or “sour” granite) will have an impact on the types of natural communities found as well as other physical characteristics such as soil type, and the presence of aquifers. Surficial geology refers to the unconsolidated earth materials (i.e.: till, sand and gravel) which overlay bedrock and lie directly beneath the soil layer. In some cases surficial geology can be very different than bedrock geology. For instance, some surficial material in New England was deposited by glaciers that carried the material long distances before depositing it onto today’s surface.

Conservation lands/Open space (public and private)

These layers give a good sense as to how much land is temporarily or permanently protected from future development in a town or study area. Conservation lands are areas that are both undeveloped and protected. Open space is not necessarily permanently protected, but it is undeveloped. The New Hampshire GRANIT database contains a conservation lands layer. The MASSGIS data set includes an open space layer. Mapping these layers will assist one to identify areas where future conservation efforts might be allocated. You will also identify potential connections between existing open space/conserved lands. Both public and private land should be placed on this map and distinguished from each other (federal, state, town, non-profit or private)

Surface waters

Display of the water bodies is a very good way to provide context for the other natural resource layers. An inventory of the surface waters should include ponds, streams, rivers, and lakes. If available, information on wetlands and vernal pools should also be included. Additional layers such as floodplains, local watershed boundaries, and stream order are good additions if available.

Groundwater resources

An inventory of the groundwater resources should include the location of aquifers, public wells, and public drinking water supplies. If possible, information on depth to water table, private well locations, water quality, water yield, and wellhead protection areas should also be included.

Potential contamination sources of ground and surface waters

Data layers that can help determine actual or potential threats to a region's ground and surface water supplies are: point/non-point source pollution sources, location of point source discharges (such as storm drain runoff, factory outflows, and old or active landfills), groundwater hazards, underground storage tanks, and locations of National Pollution Discharge Elimination System (NPDES) discharge permits.

Prime farmland soils

The 1:25,000 soils data set of the USDA Natural Resources Conservation Service (NRCS) can provide the location of prime farmland soils within your study area. Large portions of both New Hampshire and Massachusetts are not yet available in digital format. While the Massachusetts portion of the Nashua River watershed is not yet available, the New Hampshire soil data set can be acquired. Overlay of the prime farmland soils with a layer that shows where development is taking or is planned to take place can identify areas where efforts may be needed to protect remaining prime soils.

Inventory rare plant species, rare animal species and rare plant communities

A variety of data layers are available in Massachusetts and New Hampshire that can be used to identify rare plant and animal species and rare communities. In Massachusetts, there are several data layers that will provide useful information as to the potential location of rare species and exemplary communities. In order to use these data layers, certain guidelines must be agreed to when displaying the following MNHESP information: Priority sites of rare species habitats and exemplary natural communities; Estimated habitats of rare wildlife; Certified vernal pools; Potential vernal pool; BioMap core habitat; BioMap supporting natural landscape;

In New Hampshire, the NH Natural Heritage Inventory (NHNHI) has maintained a database of known rare plant populations, rare wildlife populations, and exemplary natural community occurrences (see Appendix V for contact information). This database is available in digital form through the GRANIT database. Since the data is very sensitive and there are landowner privacy concerns, the locational information of rare species occurrences has been generalized and depicted as polygons rather than points. Written permission must be obtained from NHNHI before the data layer can be used. Their website is http://www.nhdfl.org/formgt/nhiweb/.

Identify unfragmented blocks of natural habitat

Identification of unfragmented blocks of open space encourages us to look at municipalties or study areas in ways that are not familiar to most people. Many people are accustomed to thinking of the landscape as a network of roads and developed areas that are interspersed with pieces of natural habitat. This is an auto-centric view of the world. In fact, in many places, the situation is exactly the opposite. Roads and developed areas are interspersed among larger areas of natural habitat. A GIS data set can help identify such large blocks of natural habitat.

To complete this rather advanced GIS exercise use available transportation layers. All roads that are significant barriers to wildlife must be identified and buffered by a distance such as 500 feet. The exact buffer distance that is chosen is based on the wildlife species that are being considered and a need to identify areas of intact natural habitat that are not interspersed with driveways, homes, trails, and other impacts that can occur within the 500 foot zone. The buffer distance can be changed to suit different purposes. Depending on the type of road data set that you are using, the types of roads that are excluded will vary. For instance, the NH Department of Transportation Class 6 roads and the USGS Class 5 roads are not considered to be barriers to wildlife movement. These roads should be removed from the GIS dataset before the remaining roads are buffered.

After the buffer is completed, the remaining areas can be categorized according to size. For urban areas, there will be relatively few large areas of "roadless" habitat, while in more rural areas, there will be a number of quite large unfragmented areas. This exercise will identify areas where conservation effort might best be directed if one’s aim is to protect large areas of natural habitat and the wildlife species that exist in such environments. In addition, one can identify landscape connections that exist on a regional level.

Additional considerations – Watershed-based analyses

Natural resource inventories will often use town lines to define the boundary of the study area. However, it is often more useful to use a watershed boundary as the delineation of the study area. For instance, if a town has limited resources to conduct a NRI, then selection of a sub-watershed within the town might be a cost-effective means of limiting the NRI. Research on the smaller area will take less time.

In some cases, multiple towns might cooperate to produce a regional natural resource inventory. In this case, a larger watershed might be chosen that encompasses much or all of the interested towns.

Additionally, if one is trying to monitor potential pollution sources, sub-watershed boundaries will be useful when assessing potential impacts to water resources.

Site inventory by Forest Stewardship Program

The Department of Environmental Management’s Forest Stewardship Program Stewardship Program provides a good opportunity for private landowners to learn more about the forest resources located on their property. The program is open to individuals, joint owners, groups and associations, non-profits, land trusts, and other private entities that. The cost-sharing aspects of this program make high-quality assessment and planning more affordable.

As described on the Forest Stewardship Program website, "landowners of 10 acres or more who do not already have some type of management plan in place for their property are eligible to receive cost-sharing to help pay for the plan development." This includes hiring a licensed and state certified forester to write a 10 year management plan for your property. At least 50% of the cost of the plan will be covered. In some cases more will be covered depending on the acreage of the parcel. The final price of the plan will vary depending on many variables such as: access to the parcel, terrain, variety of habitats and forest cover types, availability of maps, surveys and other documents, presence of good boundary indicators, and the complexity of the landowner's goals.

The plans are organized around "stands". Stands are groupings of similar vegetation that are sufficiently uniform from a forester's perspective. Information on species composition, relative species abundance, age, basal area, and basic information on understory will be collected.

Completed stewardship plans will address any issues raised by the landowner (such as desire to generate immediate vs. long-term income). In addition, a schedule of stewardship activities for the next 10 years will be created. The final plan will include property maps that show boundaries, vegetation types, management units and other environmental features such as streams, water bodies, cultural features, roads, trails, and proposed roads and trails. Information within each of the following categories will also be collected:

- Soils – type, moisture, drainage, productivity, and erodability
- Topography – terrain, slope
- Habitat features – den trees, seeps, openings, corridors, etc.
- Special features – views, trails, specimen trees, vernal pools, ledges, etc.
- Forest condition – vigor, previous use history, any health or damage concerns

After the initial forest management plan is complete, landowners become eligible for additional cost-sharing funds as they are available to help accomplish some components of the management plan. One of these components is an inventory of the threatened and endangered species present on the parcel.

Interested landowners should call (800) 783 2311 to request a free visit by a DEM Service Forester and an application. For additional material on the program, you can also visit the website, www.state.ma.us/dem/programs/forestry/service/steward.htm.

In New Hampshire, the corresponding program is called the Stewardship Incentive Program (SIP). This program is a federal program that is administered by the USDA Forest Service and State Foresters at the federal and state level. For more information on this program contact the University of New Hampshire Cooperative Extension Service. The following website has some information on this program, http://www.fs.fed.us/spf/coop/sip.htm.

Visual Preference Survey

The visual preference survey methodology described below was used in an Alternative Futures project that took place in Southern California in the San Diego/Marine Corps Base Camp Pendleton region (Steinitz et al. 1996). The visual preference survey was one of many models that were developed in order to determine the impact that future development would have on the region.

If completed, this visual preference methodology will result in maps of the entire Nashua River watershed. Each portion of the watershed will be ranked for its visual preference based on surveys that were conducted using photographs of representative areas within the watershed. The survey can then be used as an additional piece of information when prioritizing land acquisition or formulating land use policies.

Sight is arguably the most utilized of the human senses as we assess the natural world in which we live. For this reason, conducting a visual preference survey is a very effective way to connect the values of various stakeholders in the watershed with the landscape in which we all live. This visual preference survey is based on the methods used by the USDA Forest Service (1974) and the Bureau of Land Management (1980).

This survey methodology makes use of a GIS system to create a set of maps describing the visual preference, visual exposure, and visual value of all areas within the study area. The following GIS data layers are needed to use this method: land use/land cover, road network, and the trail network (if desired),. There are three phases of the survey: 1) preferences; 2) exposure; and 3) value.

Preferences

Photographs of representative land use types in the study area are first gathered and used to create a photo survey. The land use types (i.e.: farmland, forest, low-density residential or industrial) that are selected should be identical to those present in the GIS database layer, land use/land cover. The photo survey must then be given to multiple people within the study area. Each survey participant must rank the photos in terms of preference by sorting them into piles ranked from 1 (most preferred) to 5 (least preferred). There is no limit to the number of photos that can be placed in each pile. The participant can rearrange the photos until they are satisfied with their placement. Basic information on the survey participant can also be collected, such as age, town of residence, and occupation.

It often makes sense to give the survey to a group of people that are not from the study area. The survey results on this group of people can then be compared to the results found for the watershed participants. Collection of basic information such as age and town of residence can also be used to determine if there are differences between survey participants within the watershed.

Tally the results of the survey and determine the "aggregate" preference value for all participants in the watershed. In the case of the Camp Pendleton survey in California, all of the participants, regardless of their geographical origin or their education, selected photos in similar ways. The result was just one "aggregate" ranking of the photos. In your case, there may be some interesting preference differences between the participants. If this is the case, calculate multiple aggregate scores.

Since each photo represents a land use / land cover type in the GIS land use / land cover map, the preference value for each photo can be transformed into a GIS map. The land use / land cover map, with the photo preference values placed into each land cover type is the "Visual Preference Map". It represents the "preference" that was given to each point within the entire study area.

Exposure

Exposure has to do with the visibility of each area within the watershed. The Camp Pendleton project was interested in visibility from vehicles. As a result, it was determined for all points in the study area, whether they could be seen in the foreground, middleground, or background by a passing vehicle. Within the Nashua River watershed, you may want to consider visibility from vehicles, visibility from hiking trails, as well as visibility from water bodies. Conducting visibility analyses is possible using a GIS. Upon completion of this step, "Visual Exposure Maps" can be made for each transportation type within the study area.

Value

Combination of the Visual Preference and Visual Exposure maps result in a final "Visual Value Map". Areas that are "highly preferred" and that are "highly exposed" should be given the highest visual value. In the ideal world, nothing should be done to alter the visual condition of such high value areas. Conversely, areas that are "least preferred" and "least exposed" should be given the lowest visual value. If development or change is going to take place in the landscape, then it should take place in the "least exposed" areas. The resulting visual value map can be used to inform land use decisions made by towns or to create a visual overlay district.

This methodology can be used to assess the future visual impact of development. Since each type of development will alter the land from an existing land use into another type of land use, and we already know the visual preference score for each land use type, future land use configurations can be examined in exactly the same manner as the present. This was done in the Camp Pendleton Alternative Futures project. They concluded that the majority of the region's scenic roads would be severely impacted by future development. These changes were quantified and summarized for the local jurisdictional bodies.

Within Massachusetts, the DEM conducted a Landscape Inventory in 1982 (see Appendix IV). This inventory was completed by Harry Dodson Associates. In addition, the DEM, in conjunction with the Massachusetts Historical Commission, Historic Massachusetts, Inc. and the Trustees of Reservations is in the final stages of completing the Massachusetts Heritage Landscape Inventory Pilot Project. The inventory, if completed for all of Massachusetts, will build on the 1982 landscape inventory and will be an archive of the 20th century Massachusetts landscape. The inventory will seek scenic, cultural and historic landscapes in the state such as agricultural landscapes, industrial grounds, estates, town centers, cemeteries and burial grounds, gardens, roads and trails, ocean beaches and dunes, archaeological sties, gardens, and other designed and vernacular landscapes. For more information on this project, contact Patrice Kish, Director of the Office of Historic Resources (see Appendix V).

Census Methods

The four sections below summarize many methods that are available to census populations of plant, mammal, bird, reptile, and amphibian species. Entire books can be found that treat most of these methods separately. Nevertheless, these summaries give a feeling for the many different approaches that can be used to inventory wildlife populations.

If you are a citizen unaware of the many ecological census methods, this section should help de-mystify the terms and techniques that are often used by the experts. Reading this section will not be enough to allow a citizen to undertake censuses on their own. Censuses improperly done will at best be a waste of time, and at worst can result in damage to natural systems that have been censused. Use this section to learn of the methods that can be used and then contact the appropriate experts. The information summarized below was derived from "Ecological Census Techniques: A Handbook", edited by William J. Sutherland. Other portions of "Ecological Census Techniques" are devoted to invertebrate and fish census techniques as well as techniques to monitor the non-living (abiotic) environment. However, these sections were not summarized here.

Methods to Census Plant Populations

Plants are sessile organisms (they do not move). This makes counting plant populations easier than studying something much more elusive, like a cougar. However, there are still many complications when measuring plants that must be considered. The most informative measure that can be calculated is the density (individuals in a unit area) of a plant species.

Other measures that are sometimes used with plants are the cover (area covered by the above-ground parts of a species when viewed from directly above), biomass (above-ground weight of the plants of a species), or frequency (number of samples in which a species is found) (Sutherland 1996, pg 112). Each of these measures have different biases that must be considered. Cover will often be weighted towards species with spreading growth forms, larger leaves, or more conspicuous features (such as flowers). Biomass can be biased towards species that have greater tissue density, such as woody species. Frequency, although simple and fast, is dependent on cover of a species, as well as on the size of the quadrat that is used to sample. (A quadrat is a device that is used to define sample areas within the study area. Usually these are rigid square, rectangular or circular structures made out of piping or wood that can be laid on the ground. The plant species that are found inside the frame of the quadrat are the ones that are inventoried. Quadrats will vary in size from depending on the density of plant species present. Sometimes the quadrat is not a portable frame but a place that has been randomly selected in the study area and defined by semi-permanent boundary markers.) Smaller quadrats are more likely to underestimate the frequency of a species (Sutherland 1996, pg 112).

Total counts

This method is great if there are a relatively small number of large or easily counted plants that exist in the study area. Every individual of the species you are interested in should be counted. The advantage of this method is that it has no biases, since it accurately measures density. However, it often takes too much time to survey every single individual in an area (Sutherland, 1996, pg 113).

Visual estimates of cover

Visual estimates of the cover of the species of interest are made. The cover of one species or multiple species can be recorded. Different cover classification scales can be used. One simple scale splits the area into dominant, abundant, frequent, occasional, or rare categories (DAFOR). Other schemes that can be used are the Domin or the Braun-Blanquet scales. These split cover into more discrete categories that should not be open to as much personal interpretation as the DAFOR scheme (Sutherland, 1996, pg 114). It often makes sense to measure cover for the different layers of plants present underneath a forest canopy; herb layer, shrub layer, and forest canopy layer. The herbaceous (herb) layer consists of those plants that do not have woody stems and as a results are usually located close to the ground. The shrub layer consists of woody plants that are not tree-like in growth form. Shrubs rarely exceed 20 feet in height and are usually found above the herb layers and below the forest canopy. The forest canopy is composed of the trees that grow above the shrub layer.

The major advantage of this method is the speed with which cover can be estimated. However, censusing an area based on cover is not as accurate as other methods that more directly measure species density. Species that are more conspicuous or have wider growth forms will often have a greater cover using this technique, even though the percent densities may differ from the cover numbers (Sutherland 1996, pg 115).

Frame quadrats

Quadrats are used to measure the cover, density, biomass, or frequency of plant species in a study area. Any shape can be used for a quadrat (usually a square) as long as the area contained within the quadrat is known. Larger quadrats should be used in areas with sparse vegetation or large plants while smaller quadrats should be used in areas of dense vegetation or smaller plants. Quadrat size can vary from 0.01 – 0.3 ft^2 in bryophyte, lichen, or algal communities, to as large as 500 – 3000 ft^2 when measuring trees in a forest (Sutherland 1996, pg 115).

Frame quadrats are easy to use and can be applied in a wide variety of studies. Using quadrats can often be very time consuming, especially when measuring density in larger quadrats. Caution must be used when interpreting quadrat data. Make sure that the appropriate quadrat size has been used as well as an appropriate number of separate samples collected to represent the vegetation in the study area.

Transects

Transects are usually used to measure vegetation change along an environmental gradient or through different habitats. You can also estimate density or cover of species.

The line transect method can be used to measure density by counting the number of times a species touches the line transect that is physically laid down through the study area. You can also estimate cover by determining the amount that various species cover the line transect (Sutherland 1996, pg 118).

A belt transect involves laying frame quadrats contiguously for the length of thetransect. In every quadrat, the appropriate measure should be taken (frequency, cover, biomass, or density). The change in the measure along the length of thetransect can then be correlated with environmental factors to study how and why the vegetation is changing as the environmental factors change (Sutherland 1996, pg 118).

Gradsects (gradient-directed transects) are laid out to intentionally capture all of the variation in vegetation type along a known gradient, such as an elevational gradient, or through different geological substrates. They can sometimes be hundreds of kilometers long (Sutherland 1996, pg 118).

Point quadrats

A point quadrat is a thin rod with a sharpened tip. They are most often used to obtain accurate estimates of percent cover. To do this the point quadrat is lowered through the vegetation and every time the tip of the rod hits a plant, the species is recorded. The point quadrat is lowered until it touches the ground. This method generates more accurate percentage cover estimates. It can be used only on vegetation of short height such as grasslands (Sutherland 1996, pg 119).

Harvesting

Harvesting of all of the plants within a given area can provide estimates of the percentage biomass of each species. This is a very time-consuming method that is prone to errors. It should be used if you have to get an estimate of biomass, for instance in grazing studies, where the researcher wants to determine if grazing has an impact on the vegetation present in the grazing areas (Sutherland 1996, pg 121-122).

Plotless sampling

Sampling without setting up sample plots can save time when trying to estimate density of species. Normally, at least 50 sample points are randomly chosen in the study area. When each point has been located, two different methods can be used. To use the nearest-individual method you locate the nearest tree of the appropriate species, and measure the distance from the sample point to the tree. For each point, you will obtain a measure for each of the tree species and these measurements can be used to calculate the density. Calculate the mean of the distances over all the samples (A_1). The density of trees is calculated using the equation: Density – $1 / (2A_1)^2$

The second method is the point-centered quarter method. At each point, two perpendicular straight lines that cross at the sample point are measured out, creating four quadrants. In each quadrant, the distance to the nearest tree is measured. The distances from the four quadrants is taken and averaged at each point. The mean of those averages is then calculated (A_2). The density is then calculated using the equation:

Density = $1 / (A_2)^2$

Seed traps

Seed traps are placed on the ground in order to catch the seed rain falling from the forest and shrub canopy above. Normally the traps are lined with a sticky substance that will catch the seeds. Regular removal, counting and identification of seeds must take place in order to accurately document the fluctuations in amount and type of seeds that are falling.

Marking and mapping individuals

Marking and mapping of individuals can be very useful if you are interested in tracking growth rates and survival of individual plants through time. This method can be used at a variety of scales, from very small, densely populated plots to entire forests, when tracking very rare tree species. Care must be taken to insure that individuals can be identified during subsequent visits to the site.

Vegetation mapping

Vegetation mapping involves classifying portions of a study area into different vegetation types. A vegetation type is simply an area with similar species grouping and/or plant growth form (Sutherland, 1996, pg 132). Many different vegetation classification schemes exist and it is important to determine an appropriate scheme if a vegetation map is needed. In Massachusetts, many studies will make use of the classification of the natural communities of Massachusetts that was published by the Massachusetts Natural Heritage and Endangered Species Program (MNHESP) (Swain and Kearsley 2001 (http://www.state.ma.us/dfwele/dfw/nhesp/nhpubs.htm). You can also create your own categories based on the dominant species or species combinations or use very simple schemes such as coniferous, deciduous, mixed, etc.

A vegetation map can be completed using ground mapping that is informed by field work and careful delineation of boundaries between different vegetation types. An alternative is to use remotely sensed imagery (satellite or airplane acquisition) of an area followed by visual separation of the vegetation types using manual or computer-assisted means. Parts of the spectrum other than the visual portions can be acquired (infrared or ultraviolet) which allows the detection of such things as plant productivity.

Phytoplankton

Phytoplankton are small single or multi-cellular plant species that exist in both fresh and marine environments. Often it is useful to sample such species as indicators of water quality or simply to determine which types of phytoplankton are present. There are many different sampling schemes available. Briefly, however, these methods involve sampling a fixed volume of water (ideally from a fixed depth) at multiple locations in a stream or lake, preserving the sample with appropriate chemical solutions, and then inventorying the species or types of phytoplankton in a laboratory. Sometimes the concentration of chlorophyll a is obtained, giving a relative measure of phytoplankton in the sample

(Sutherland, 1996, pg 136).

Methods to Census Mammal Populations

Although we are very aware of many mammals that coexist with us (such as deer, coyote, raccoons, chipmunks, rabbits, and squirrels) there are many more that are much more elusive creatures. Some of these are nocturnal species while others are simply extremely sensitive to humans and are rarely seen. The challenge with mammals is how to get an accurate idea of the size of their populations. Often, you must turn to other signs of their presence, such as scat?, tracks, or feeding signs. Even with the larger, more commonly seen species, it is difficult to determine what percentage of the population one is actually seeing. As a result, the information collected often results in an index of abundance rather than a measure of population density. Several different types of census methods are described below.

Total counts

A total count is an attempt to count every individual of a certain species that exists in predefined areas. It is often a challenge to determine exactly which area an individual falls in, and can be a problem if repeated observations of the same area are made. Different observers may delineate the areas differently. This method is useful if the species are very visible and do not move between the sample areas quickly. An example of a species that lends itself to counts is the Bison (Sutherland, 1996, pg 260)

Counting Breeding Sites

If a species is elusive, but leaves conspicuous signs of breeding or habitation, such signs can sometimes be used to determine density. For example, beaver lodges can be readily counted from the air (Sutherland, 1996, pg 265). When using this approach, it is important to distinguish between breeding sites that are currently or recently used and those which are abandoned. If you cannot distinguish between the two, it will result in density over-estimates as the unoccupied sites are included. Caution should be used with this technique. Species with lairs (dwelling of a wild animal) will often move the offspring after having been detected and disturbed (Sutherland, 1996, pg 265).

Strip and Line Transects

The line transect method involves delineating a line through the study area and then traveling along the line and recording all of the individuals that are found on each side of the line. To use the strip transect method, the study area must be divided up into strips of a set width, and then a randomly selected subset of the strips are selected in which surveying must take place. Often it is not possible to assume an ability to access all parts of a study area. In such cases, surveying from existing roads may be the only option. However, some species avoid roads and their numbers would thus be underestimated. The distance from the line transect should be estimated in order to eventually calculate density of a species. In the strip transect method, the number of individuals seen within the strip can be converted to a density.

Care must be taken when using this method. Experience of the surveyor can greatly change the results that are obtained. In addition, more secretive or inconspicuous species will often result in estimates being too low.

Aerial Strip Transects

Aerial surveying is ideal for large and conspicuous species that live in open habitat. To use this technique surveys are taken along predefined transects out of a plane that is moving along at a fixed speed, at a fixed height. The width of the transect must also be fixed before beginning the survey. As with other transect techniques, caution must be taken to conduct the censuses with experienced surveyors. Other factors should be considered: counting efficiency usually decreases after three hours, the light and shade conditions are not ideal in the early morning and late evening, and midday censusing will often miss many individuals since they have moved to cooler shaded areas not visible from the plane (Sutherland, 1996, pg 266).

Individual Recognition

This method requires keeping track of all individuals and the characteristics that allow their identification. Such data sets should be created only if the species is long-lived and there is adequate staff support to continue this technique, as it is very time intensive. This technique has been successfully used with various large carnivores ,humpback and right whales, as well as with chimpanzees (Sutherland, 1996, 268).

Counting and Mapping Calls

This method has been used very effectively with bats, whales, and seals although it has also been used with other species such as lions or hyenas. It involves counting the number of calls / vocalizations or clusters of calls that can be detected and using this as an index of abundance. It can sometimes be used to help delineate the home range or territory of an individual or group as they move within the home range (Sutherland, 1996, pg 269-270).

Trapping and Mark-recapture methods

This method is especially effective with many small mammal species that cannot be visually surveyed. Traps that capture the individuals while live are most often used. Most such traps contain a lever that is triggered when the individual is inside the trap. Pitfall traps can also be useful if you can dig holes in the ground. Effectiveness of the trapping is often dependent on experience of the trapper. For instance, most small mammals will not cross open clearings, but instead move along objects such as logs if possible. Placement of traps to cater to such behavior can greatly increase the success.

Once a successful trapping regime is set up, population sizes can be estimated using mark-release-recapture methods. Mark-recapture methods are based on the following idea: One can catch a sample of individuals from a population, mark them and then release them into the population again where they will mix with those individuals that are not marked. If you then proceed to trap a new sample of individuals from the population you will catch both marked and unmarked individuals. An estimate of the total population can be obtained using the following formula: $N = (n_1 * n_2) / m_2$ where N is the total population, n_1 is the number of animals in the first trapping session, n_2 is the number of individuals caught in the second trapping session, and m_2 is the number of marked individuals caught in the second trapping session (Sutherland, 1996, pg 17).

A number of assumptions must be met to use this formula: the population must mix uniformly after the first capture session, the probability of capture must be equal for previously captured and never before captured individuals, the mortality of captured individuals must not differ from that of uncaptured individuals, and the population size cannot change due to births or deaths (Sutherland, 1996, pg 18). There are many different variations of this basic mark-recapture method if the above assumptions do no hold true or if multiple trapping sessions are taking place.

Another technique that is not as time-consuming is to set up tubes that contain double-sided tape and will capture the hair of individuals. The hair can later be identified. There is no need to closely monitor the tubes as the animal was not trapped and species identifications can be made months after the field-work actually took place (Sutherland, 1996, pg 276).

Counting Dung

Counting dung provides a measure of the relative density of a species in an area. If one has estimates of the amount of dung that is produced per day, then you can obtain estimates of the number of mammal-days that are represented in the surveyed area. For some of the more elusive species this may be one of the only methods used to regularly survey the population. Care must be paid to the rate at which dung will decompose in different environments and during different seasons as well as with the rate at which it is produced when diet and metabolism rates may change throughout the year.

Feeding Signs

Many species leave unique feeding signs that will allow species-specific identification of their presence. This can be useful to determine presence and distribution of species, and can give only a relative index of a species abundance.

Counting Footprints and Runways

Looking for footprints or runways in an area can give a quick indication of presence and distribution of a species. If time is available to visit a site repeatedly, an area can be checked for tracks and then raked clear after each site visit. Often tracks will be concentrated in more moist areas because of the presence of a water source. Extraploting presence of the species to all areas within the region may not be valid. To get around this problem, portable tracking stations can be set up in locations with different characteristics.

Calculating the density of runways in a certain area can provide useful information on behavior and distribution.

Methods to Census Bird Populations

Sutherland points out that birds are probably the easiest animals to census. They are often brightly colored, relatively easy to identify, and often very vocal. All of these things contribute to being able to census them easily. In addition, they are very popular objects of study, which means qualified experts can often be found easily. Monitoring of bird populations can be a great way to get an indication of the overall health of ecosystems (Sutherland, 1996, pg 227). Most census techniques concentrate on obtaining estimates of breeding population sizes.

Methods to census birds can be split into two types of methods: the first involves techniques to monitor species that are evenly distributed across the landscape (most New England species fall in this category); the second set of techniques is used for species that are clumped in distribution (the Great Blue Heron colony off of Route 2 in Littleton? is an example of clumped distribution).

Counting Nests in Colonies

Colonial nesters are fairly easy to census since many individual pairs are located close to each other. The type of census technique will vary depending on the type of habitat used. Colonies can be found on cliffs, in trees, in burrows, or directly on the ground. Censusing should take place when the highest number of breeding pairs is present. Take care to census at the right stage of the breeding cycle (preferably midway through incubation to the early nestling phases) as well as at the right point during the day due to feeding schedules. Extra care must be taken when censusing burrows or cliff faces because of difficulty of actually verifying bird presence or because of access considerations.

Counting Leks

A lek is a communal display area where males will gather in order to attract females to mate. Lekking can take place for much of the breeding season but is usually at its peak just before egg-laying and just before dawn (Sutherland, 1996, pg 233-234). In order to census leks, the researcher must know where they are located and when the peak in lekking males will take place during the season. Once this is established it is straightforward to count the number of breeding males present in the lek. Leks can vary in size so care should be taken to try to identify all of the leks present within a given area.

Counting Roosts

Some species of birds roost together at night time, or for coastal species at high tide when foraging is not possible (Sutherland, 1996, 234). Since many birds can be counted while they are roosting, this method can be an efficient one. However, it does not obtain an estimate of the breeding bird population.

Counting Flocks

Many birds can sometimes be present in flocks. This will often make it difficult to accurately estimate the number of birds contained in the flock. If the flock is on the ground or in trees, use landmarks to divide up the groups before counting them (Sutherland, 1996, pg 235). When in the air, small flocks are often underestimated while large flocks are often overestimated (Prater 1979, cited in Sutherland, 1996, 235).

Counting Migrants

Many species that migrate will pass through a bottleneck along their migration route. These bottlenecks can often be fairly small areas, so setting up a small number of census stations for a small portion of the year can often obtain very good estimates of populations. For example, raptors and storks pass through the Straits of Gibraltar as well as the Bosphorous in Turkey on their way south (Sutherland, 1996, pg 236). In the United States, many raptors can be found using the ridgelines of north/south mountain chains such as the Appalachians and the Rocky Mountains. In Massachusetts, Mount Watatic, Mount Wachusett, and Mount Tom State Reservation are some of the best sites to view hawks during the fall migration. Visit the HawkWatch websites listed below to learn more about these sites and the Northeast HawkWatch program (http://massbird.org/emhw/where.htm, http://www.battaly.com/nehw/)

While it is known that many species, particularly songbirds migrate at night, it is difficult to acquire estimates of the numbers of birds migrating. Some species call to each other when flying, and this can be recorded and later analyzed (Evans 1994, cited in Sutherland, 1996, pg 237). Some researchers have successfully used the bright background of the moon to census birds as they fly in front of it (Lowery and Newman 1966, Alerstam 1990, cited in Sutherland, 1996, pg 237). Many migrating bird species are attracted to the warning beacons on radio towers, and will become disoriented and often collide with the towers. Although unfortunate, this method can provide a general idea of the types of species that were migrating overhead.

Territory Mapping

Many species of birds are territorial during the breeding season. Territory mapping can be an effective census method during the breeding season and ideally will show the researcher how many different bird species make use of the resources in a small study area (Sutherland, 1996, 238). Usually study plots are between 15 and 80 ha in size (37 and 200 acres); plot size is smaller in closed habitats and larger in open habitats since censusing is easier and quicker (Sutherland, 1996, pg 238). The study area must be visited multiple times during the breeding season, usually leaving several days between each site visit. On each visit each bird encountered is noted, bird behaviors (alarm calling, nest building, etc.) are noted as well as location of nest if possible.

At the end of the study season, all of the behavior points should be recorded onto one map for each species censused. The clusters of points present on the map should roughly delineate territories that were maintained throughout the season. This information can be very helpful in learning about bird / habitat relationships (Sutherland, 1996, pg 239-240).

Point Counts

Once one has enough experience with bird identification it opens the possibility of conducting more rigorous bird counts. If bird count data is collected in multiple places within a study area over the long-term, one can begin to learn about the status of many bird species.

The point count method is described below. It can be used to detect the presence-absence of birds at one particular site. If a group of citizens are truly interested in beginning a bird monitoring program, it is very important to spend time creating a good methodology for the project. If an appropriate methodology is not developed, the results may not be useable or robust enough to back up management or conservation objectives. A little time at the outset will serve you well in the future.

To conduct a bird point count, the researcher stands at the center of a certain location and counts birds. The area surveyed is usually within a set radius. The radius varies depending on the purpose of the point count but is often a distance such as 20 meters. The point count should be done at the same time of day, and for a specific duration, such as 10 minutes. Approach the count location quietly and stand for 2 minutes silently before recording birds. Record all birds that were flushed from the area when you were approaching the location. During the point count, all birds that are seen or heard should be recorded on data sheets. Distinctions should be made between birds that are on structures within the point count area, birds that fly through the point count area, and birds that fly over the point count area. Keep track of the number of birds that you see of the same species. However, make sure the birds you are seeing are not ones that were already counted. Take note of any unidentified birds that were seen and identify them to the closest taxonomic level possible. Take note of the weather conditions (wind intensity, temperature, and percent cloud cover). Avoid counting if it is very windy or rainy as this is well known to affect bird activity. Appendix XII has some sample data sheets that can be used when conducting bird point counts. A complete methodology for bird point counts can also be found at the following website, http://www.fs.fed.us/pnw/bird-populations.

Line Transects

Line transects are most often used in large, open areas of habitat such as fields, open sea, or from the air. The transect should be randomly placed in the study area, otherwise bias may enter into the census if existing routes such as roads or trails were used for the transect. If multiple transects are being censused, it is important that they are far enough from each other so birds are not counted twice. A variety of methods exist to count the birds and then calculate a density of each bird species. Some census all birds seen to an infinite distance, other techniques census only a narrow band a fixed distance from the transect, while still other methods combine these two techniques (Sutherland, 1996, pg 247).

Transects from the sea and air can also be used to estimate bird densities. In these methods, the speed of the ship or plane is used to determine how long to census for bird populations. In a plane, a fixed strip of land should be censused, while from a boat, a researcher will often look out from only one side of the boat (Sutherland, 1996, pg 248).

Response to Playback

Some species that are very hard to locate will respond to playback of their call. This technique will result in population estimates that are more likely to reflect the density of such birds. Burrowing owls and several American Raptors are good examples of this (Sutherland, 1996, pg 249).

Mist Netting

Mist netting differs from other techniques because one can gather information not only on population changes from year to year, but also demographic and long-term survival of individual birds (Sutherland, 1996, pg 250). This is accomplished by setting up mist nets in fixed locations for fixed periods of time, then monitor and band the birds that are caught in the nets. Care must be taken to set the nets out at the appropriate times and for appropriate durations. In addition, the type of mesh size used will impact the type of birds that are caught.

Mark-Release-Recapture Techniques

This technique can be used to estimate population sizes. Once marked, it is not always necessary to recapture birds if the bands can be seen from a distance. Considerable experience is needed to use this technique. See a description of mark-release-recapture techniques in the mammal section above.

Timed-species Counts

This technique is a quick way to estimate relative abundance of species present in a study area and to create bird species lists. This technique is based on the assumption that common species are more likely to be seen first, while more rare species will be seen later in the censusing period. Thus, the amount of time it took to first see a species can be used as an index of abundance. Once a common species is observed, no further notes need be taken for that species. Instead, time can be spent seeking out other, rarer species in the area. Thus, this is a good technique to obtain more complete bird species lists, since more time is spent looking for birds rather than noting the presence of more common bird species.

Methods to Census Amphibian Populations

Monitoring amphibian populations is a challenge. Since they can hibernate or aestivate for long periods of time, it is often difficult to detect them. This is usually done by “catching” individuals during the breeding season. Even this is difficult as optimal breeding conditions may not happen frequently and the researcher must be ready to census at a moment’s notice when the conditions are right. Further, there is high mortality between egg and adult stages in most amphibians, and estimating breeding population size is difficult (Sutherland, 1996, pg 205). However, there is growing consensus among researchers that amphibians are declining and going extinct in many areas of the world, even in pristine habitat (Sutherland, 1996, pg 206).

Recognizing Individuals

In order to estimate population sizes, mark-release-recapture methods are usually used. However, to do this, an ability to recognize individuals must be developed. Historically, the most common technique used to do this is to clip the toes of individuals captured in a way that allows for re-identification in the future. This technique is coming under more scrutiny lately. It is becoming more common to use the variable skin marking present on many species to distinguish individuals (Sutherland, 1996, pg 207).

Drift Fencing

This technique takes advantage of the fact that many amphibians migrate to breeding sites each year, these sites most often being small water bodies. A drift fence is set up completely encircling the water body if possible. The fence must be constructed so it is not passable and forces individuals to move along the fence until they are trapped in pitfall traps placed regular distances along either side of the fence. This allows estimation of migration into and out of the breeding site. Traps should contain holes to allow water drainage so individuals do not drown and also contain cover (leaves, twigs, rocks, pot shards, etc.). During peak movement the traps should be checked very frequently or high mortality of the population will take place. This technique, in combination with mark-release-recapture can provide quite accurate estimates of population size (Sutherland, 1996, pg 209).

Scan Searching

Scan searching is a quick way to get at relative abundance of amphibian populations. However, it is no substitute for mark-recapture studies. Usually the number of individuals detected per person hours is measured. Censuses are best taken at night when animals are most active. Sometimes counting egg masses can provide an estimate of the number of females present in an area (Sutherland, 1996, pg 212).

Netting and Trapping

Netting involves capturing all individuals possible with nets in a breeding site. This will usually not provide good estimates of population numbers unless combined with a mark-recapture study. Efforts should be made not to damage water plants or other aquatic habitat. Traps can be set up in water bodies or on land. When setting traps for turtles, it is important to allow for fluctuating water levels that may cover the traps. Create an "escape hatch" at the top of the trap in case the water level does rise in between visits to the study site. Individual dispersal behavior should be known because the orientiation of the trap can take advantage of daily movement patterns. For example, many aquatic salamanders move from deep water during the day to shallower waters near the edge of ponds at night (Sutherland, 1996, pg 214).

Transect and Patch Sampling

This method involves laying out a transect and then recording all individuals seen along the transect. Rocks and potential cover are usually overturned within a set distance from the transect. While this provides only an index to abundance it can be very useful to link species abundance to other environmental and physical characteristics that can change quickly along the transect gradient (Sutherland, 1996, pg 215). Patch sampling uses similar techniques but the survey is confined to a defined set of area.

Methods to Census Reptile Populations

Most census methods for reptiles involve capturing individuals and noting things such as weight, six, size, reproductive condition, and parasite load (Sutherland, 1996, pg 218). Mark-recapture methods are usually used if estimate of the population size is desired.

Hand-capturing

This is the simplest method used to capture reptiles. The techniques used vary with species and with the type of reptile. Some species are nocturnal while others must be looked for during the hotter times of the day, when basking is taking place. Care and training is a must when capturing venomous snakes. Once captured, relevant physical characteristics can be noted and the individual marked for later recapture (Sutherland, 1996, pg 220).

Noosing

This technique is useful for active species that usually cannot be hand-caught or that live higher up in trees. It is simple to make nooses out of sticks or more official materials like telescoping poles threaded with a string. Once caught measurements and marking can take place.

Trapping

Pitfall traps are the most common type of trap. As with amphibians, this is simply a bucket or container of appropriate size that is embedded in the earth so the opening is flush with the ground. Holes must be placed in the bottom of the traps along with some cover materials. The size of the trap will result in different types of species being captured and sometimes various sizes should be tested before choosing one. Traps must be visited regularly or the trapped individuals can die from predation, dehydration, or starvation (Sutherland, 1996, pg 222).

An alternative to pitfall traps in rocky areas is a “wire funnel tap” (Fitch 1987). These wire mesh traps have a funnel that leads the individual into a central chamber. Once trapped, the individuals cannot exit out of the small entrance through which they entered. These traps are usually the culmination of a drift fence that leads individuals to the mouth of the trap. These types of traps can be very effective in aquatic settings when trapping turtles (Sutherland, 1996, pg 223).

Marking Individuals

There are many different techniques used. Paint or nail polish will usually provide markings within short periods of time. Toe clipping is sometimes used in small lizards. Scales can be clipped and then cauterized in lizards and snakes. Branding can also be used with a hot or freezing branding iron. Turtles and tortoises can be marked by clipping the edge of the carapace (shell). More recently, passive integrated transponder (PIT) tags have become available and can potentially provide a permanent “mark” and individual recognition (Sutherland, 1996, pgs 224-225).

Aquatic Inventories

In the "Simple" aquatic inventory section, we described several basic inventory techniques. If implemented, they would help a group of citizens compile basic information on the rivers, streams, wetlands, and other aquatic resources present in their area of interest. If such basic information does not exist in your town or study area, we strongly urge you to concentrate time and resources collecting the basic information. If, however, such information has already been collected in some form or another, time may be invested in some of the more complicated assessment techniques that are described below.

New England Regional Monitoring Collaborative

Intensive Habitat Assessments are very similar in nature to the Rapid Assessments described above in the Simple Inventories section. However, the assessment focuses on the quantitative measurement of the physical characteristics rather than visual evaluation. Characteristics measured include stream flow, depth, width, substrate type, bank stability and erosion potential, instream deposition, and instream cover.

Once the physical characteristics of the river have been measured, it is advised to conduct a Benthic Macroinvertebrate Assessment as well. This is an inventory of the large aquatic invertebrates (animals without spines) that can be collected from the rocks, wood, and bottom of the river. They are collected, identified, and analyzed. Conducting macroinvertebrate assessments is very important because these species respond to different physical, chemical, and biological regimes present in streams and rivers. If human alterations of physical or chemical characteristics of the waterway takes place, monitoring the invertebrate populations will help insure that impacts are detected. Not only can negative impacts be detected, but the restoration of rivers can also be monitored using the macroinvertebrate surveys.

NERMC has two levels of course related to Benthic Macroinvertebrate Assessments: a Streamside Assessment and an Intensive Assessment. The Streamside assessment is described here, while the Intensive Assessment is described in the Complex Inventory section of the document. The Streamside Assessment course teaches students to inventory invertebrates entirely in the field. Invertebrates are collected and identified to the major group level (mostly class and order, some family if possible). Relative abundances are calculated (dominant, common, rare, or none) as well as diversity. The total number of invertebrates are categorized into numerical ranges. Finally, each site is given an impairment ranking of "not impaired", "moderately impaired", and "severely impaired".

An intensive invertebrate assessment involves the collection and preservation of the species that are collected. They are brought to a lab where identification is made as accurately as possible, mostly to the family level. With this additional level of accuracy, calculations for the total numbers, diversity, pollution tolerance, feeding ecology, and community composition can be made. As before, the impact sites are compared to reference sites and the site is considered not impaired, moderately impaired, or severely impaired.

The NRWA conducted three benthic macroinvertebrate and habitat assessments during the summer of 2000. The streams that were studied were Phillips Brook, Monoosnoc Brook and Nissitissit Brook. The invertebrates were identified to the family level for each of the brooks. The habitat assessment was conducted for the 100 meters within which the macroinvertebrate study was conducted. The methodology of the habitat assessment followed the Rapid Bioassessment Protocols of the EPA. Three sites were sampled in the Phillips and Monoosnoc Brooks, while only one site was sampled in the Nissitissit Brook, which served as a reference for the other two streams. There are plans to conduct further stream assessments during the summer of 2003.

For information on the courses described above, contact the NERMC at (413) 545 5532 or visit the website http://www.umass.edu/tei/mwwp/nermc.html.

NRCS Stream Ecological Assessment Handbook

The NRCS handbook is the third tier in the NRCS stream assessment protocols. The NRCS National Water and Climate Center has developed a set of flexible training materials that can be used by State Office or Area personnel to provide training. There are several modules that can be taught, each taking one or two days of training. Please contact your NRCS State Biologist to discuss this program and the training modules.

Wetlands

Wetland inventory - level II

The components of the level I wetland inventory of the Izaak Walton League of America were described above. Level I inventories aim to establish baseline information on the wetlands of a town or study area. Level II inventories should be initiated if more information is needed on the wetlands in a specific area. The level of commitment needed is significantly higher, both in terms of time and finances. Groups of local citizens will need to be contacted or formed in order to complete a level II inventory. Scout groups, local bird-watching associations, conservation commission members, and members of local land trusts are all potential contributors to level II inventories.

The types of activities involved in the inventory are: vegetation survey transects, soil sampling, hydrological monitoring, bird surveys, amphibian and reptile surveys, mammal surveys, and water quality monitoring. To properly establish a level II monitoring program, a Quality Assurance Project Plan (QAPP) document should be written before initiating the project. QAPPs are described below in the complex inventories section. If properly written and formulated a QAPP will add credibility to the program and will insure that the data is collected in a systematic manner.

The document "Handbook for Wetlands Conservation and Sustainability" goes into detail about the methods involved in each part of the inventory. For more information on and to order the Izaak Walton Leage of America "Handbook for Wetlands Conservation and Sustainability" visit the following website: http://www.iwla.org/sos/handbook/. To provide a better idea of the type of work involved in a level II inventory, refer to the Izaak Walton League of America data forms provided in the Handbook.

New Hampshire methods to inventory wetlands

The New Hampshire Method of Evaluating Wetlands was developed in 1991. (Amman, A., and A. L. Stone, A Method for the Comparative Evaluation of Non-Tidal Wetlands in New Hampshire, 1991.) A prime wetland is defined as a wetland that is worthy of extra protection because of it s unspoiled character, uniqueness, or fragility. All prime wetlands must have over 50% hydric A soil (very poorly drained soils). The New Hampshire method uses a ranking system based on 12 criteria. These criteria are as follows: Ecological integrity, wildlife habitat, fin fish habitat, educational potential, aesthetic quality, water based recreation, flood control potential, groundwater use potential, sediment trapping, nutrient filtering, urban quality of life potential, and historical site potential.

Any municipality, by its conservation commission, or, in the absence the planning board or governing body may undertake to designate, map and document prime wetlands lying in or partially in its boundaries. After approval by any town council meeting, the maps (to scale) can be filed with the designations to the Department of Environmental Services Wetlands Bureau (http://www.des.state.nh.us/wetlands/). (State of New Hampshire, RSA 482-A:15, Prime Wetlands.)

Delineation of Bordering vegetative wetlands

A bordering vegetated wetland (BVW) is a bog, swamp, marsh, or wet meadow that borders on a water body. The soil in BVWs is saturated with water such that they support plants that are uniquely adapted to wet conditions. Under the Wetlands Protection Act, BVWs are protected. Their exact definition can be found in the Wetlands Protection Act (310 CMR 10.55).

The local conservation commission is the political body that administers most parts of the Wetlands Protection Act. The most important task of a conservation commission is to accurately delineate the boundary of bordering vegetated wetlands in each town. Based on these delineations, permits will be granted or not granted to those interested in developing or altering the landscape.

In 1995, the Massachusetts Department of Environmental Protection (DEP) revised its regulations in order to provide a more scientifically based definition and set of procedures for delineating bordering vegetated wetlands. This was done in the hope that it would minimize the number of contested delineations made by conservation commissions.

Although it is the responsibility of conservation commissions to delineate wetlands, the more citizens that are familiar with the methods, the better off a community will be. There are several ways that interested citizens can learn more about delineating wetlands. The Massachusetts DEP has written a guide entitled "Delineating Bordering Vegetated Wetlands under the Massachusetts Wetlands Protection Act" that will familiarize citizens with the methodology. See Appendix IV for the complete reference.

In addition, the Massachusetts Association of Conservation Commissions (http://www.maccweb.org/home.html) has a certificate training program that will teach conservation commission members or interested citizens the basics of commission responsibilities and operations as well as open space planning, protection and management, and wetlands permitting issues. Upon completion of the course, the students will receive a certificate and their municipality will be notified of their successful completion of the course.

Once citizens are educated about the importance of wetlands and their environmental function, they can help commission members monitor the activities taking place on a local level. .

Other aquatic inventory techniques

On-site non-point source pollution evaluation

The New England Regional Monitoring Collaborative (NERMC) also conducts training for evaluation of on-site non-point source pollution. This evaluation system concentrates on the identification of erosion, sedimentation, and run-off problems that exist in watersheds. This course advocates looking at rivers and streams from a watershed perspective. Rather than focusing on only the characteristics in the river, students are taught to investigate the nearby water as it moves towards the river. Students are taught to look for evidence of erosion given site characteristics such as soil type, slope, and site history. They are also taught to look for sedimentation problems and assess if significant amounts of sediment are being transported off-site. The technique can be used on existing conditions or it can be used to evaluate the likely impacts of proposed projects.

Combination inventories

The two data forms below are taken from a draft wildlife habitat guidance document for protecting and evaluating wildlife under the Massachusetts Wetlands Protection Act. The data sheets are based on ones used to teach wildlife habitat evaluation at the University of Massachusetts. Contact the University of Massachusetts Extension Natural Resources and

Environmental Conservation Program with any questions about the forms (see Appendix V). The Checklist and the Wildlife Habitat Evaluation data form are best used for parcel-size inventories. The methodology in these two forms would be impractical if used at the scale of an entire municipality.

Critical Habitat Features and Activities Checklist

The Checklist (see Appendix XII) is a fairly simple method that can be used to determine if there are critical wildlife habitat and natural resource features in a study area that will likely be impacted by proposed activities or projects. The checklist is designed to identify small-scale projects that may impact critical wildlife habitat. Larger projects (greater than 5000 square feet) should be evaluated using other methods. It is designed to help conservation commissions determine when sufficient grounds exist to conclude that significant adverse impacts may take place to wildlife habitat functions.

Moderate to high levels of familiarity with the habitats of Massachusetts is required to complete the checklist. The checklist can be used each time a project needs to be assessed. Alternatively, a GIS could be used to create a separate layer of information for each of the critical habitat features described in the checklist. When a potential project comes up for review, the GIS data set could be used to conduct preliminary investigation of the impact that the project would have on the critical habitat features. For more information on the checklist, contact Scott Jackson of the University of Massachusetts Extension, Natural Resources and Environmental Conservation Program (http://www.umass.edu/umext/nrec/) (see Appendix V).

Wildlife habitat evaluation field data form

The aim of the form is to help interested citizens, municipal officials, or professionals determine the wildlife habitat potential for any given area. To complete the data form, information is collected in each of the following sections: general information, site description, important habitat features, landscape context, and habitat degradation. A medium to high level of technical expertise is needed to complete one of these forms. Familiarity with soil classification systems, plant species identification, plant community identification, and wetland identification is necessary in order to accurately complete a data form. If such a form is consistently applied to the open space areas of a study area or town, it will create a very solid information base on which land use and planning decisions can be made. Contact the University of Massachusetts Extension Natural Resources and Environmental Conservation Program with any questions about these forms (see Appendix V). You can also visit their website: http://www.umass.edu/umext/nrec/index.html.

Complex Inventories

To complete the inventories and assessments described below, high levels of technical expertise are required. In most cases, a sustained effort will be required for significant amounts of time. Often, the projects will last multiple years or will represent an ongoing commitment that runs indefinitely into the future. Significant funding is required for this type of inventory.

Quality Assurance Project Plans (QAPP)

When undertaking monitoring projects that are complex, it may be necessary to prepare a Quality Assurance Project Plan (QAPP). A QAPP is normally created if a complex monitoring project is initiated that will take repeated measurements over the course of many years or many times at different locations in a study area. In either case, it is critical that systematic methods be used to collect the field data throughout the project. The QAPP is a document that outlines the methods that your monitoring project will use in order to collect samples, record data, and report data and important findings. If the monitoring project is implemented primarily with the help of volunteers, the QAPP is very important to add credibility to the project and to keep the monitoring efforts consistent.

There are two components to a QAPP, Quality Assurance and Quality Control. Quality Assurance describes the management system for the project. This includes organization, planning, data collection, documentation, evaluating, and reporting activities. The Quality Control is a description of the methods used to conduct routine technical activities in order to control for possible errors in data collection.

Development of a QAPP is a crucial step in order for a project to gain credibility with state and federal agencies that might cooperate with the volunteer effort. The QAPP can be designed so that collection methods are similar to those used by other similar programs or agencies, insuring comparability of results. Other reasons to develop a QAPP include:

- A QAPP is required to receive funding from the EPA.
- The QAPP will standardize the collection methods and make the data set useful over the long-term.
- Once compiled, the QAPP will decrease the time it takes to educate new volunteers.
- A QAPP will make a project more credible.

For more information on the preparation of QAPPs, refer to the EPA guide "The Volunteer Monitor's Guide to Quality Assurance Project Plans" or “The Massachusetts Volunteer Monitor’s Guide to Quality Assurance Project Plans”. These documents describe the steps necessary to create and implement a QAPP. For more information on QAPPs, contact the Mass Water Watch Partnership or visit their website at www.masswp.org. In addition, Martha the NRWA wrote a QAPP for their water monitoring program. Contact Martha Morgan at the NRWA for more information on the program or the QAPP.

Terrestrial

The complex natural resource inventories and habitat assessments described below are by no means a comprehensive list of the many different techniques that exist. However, the descriptions of the methods provide a feeling for the level of expertise that is needed in order to successfully complete such an inventory.

Regional Habitat Assessments

The Mass Audubon Ecological Extension Service, under contract with the Nashua River Watershed Association and the Massachusetts Watershed Initiative's Nashua Team ,conducted a regional habitat assessment for the entire 532 square mile Nashua River watershed. Below is a description of the background and methods that were used to conduct the assessment. The conclusions of the assessment and the descriptions of the focal areas are discussed in Section 3.3 of the document. Please refer to the Mass Audubon document, “Focusl Areas for Wildlife Habitat Protection in the Nashua River Watershed” (Appendix IV) for a detailed summary of the methods and findings of this regional habitat assessment (Collins 2000).

Background

The following background description was taken, with permission from the Collins report (ibid). Preservation of long term habitat viability requires a systematic approach to the identification and acquisition of valuable habitat to meet the needs of large and wide-ranging floral and faunal species which require specific natural communities as habitat.

Regional habitat assessments are intended to identify the most important areas for wildlife habitat protection at the watershed level. The maps produced depicting habitat protection focus areas within the watershed will help towns, land trusts and state and federal agencies as a first iteration in a multi-step process of identifying priorities for land acquisition.

In order to complete this project, Mass Audubon spoke with dozens of professional and amateur wildlife biologists and naturalists to identify focal species and the landscape elements they require. In addition, they relied on MassGIS roads, land use, topography, wetlands, and other data layers, topographic maps, and aerial photographs to identify large areas of interest. They also used MA Natural Heritage & Endangered Species Program data to locate habitat for rare, threatened, and endangered plants and animals. Combining this information, “Focus Areas” were generated that included large undisturbed areas as habitat cores, smaller focus areas as stepping stones, and corridors to allow wildlife movement across the larger landscape. Very limited amounts of field work were conducted in the watershed due to severe limitations to the project timeline . Figure 1 shows the focus areas that were identified by this study -- a first cut at identification of priority areas -- as well as the stepping stone areas and the corridors. More detailed studies of the focus areas are intended to be undertaken at the local level: as was begun in 2002 (see below).

Methods

In order to identify the focus areas in the Nashua River watershed, Mass Audubon used the focal species method to identify umbrella species, habitat disturbance indicators, and habitat quality indicators. This method makes use of expert opinion to identify important focal species in the watershed. Once all of the focal species were nominated, experts were again asked to identify the key areas of core habitat in which the focal species live. Attention was paid primarily to mammal, bird, amphibian, and reptile focal species. These focal species and their associated habitats were used to inform the next stage of the focal area selection (Collins 2000).

A GIS was used to analyze land use and open space patterns in the watershed and to locate areas of potentially significant wildlife habitat. The result of this GIS analysis was the identification of the large, medium, and small focus areas and the riparian corridors in the watershed. Additional information that was used included municipal Open Space and Recreation Plans (to identify local conservation priorities), interviews of ecologists, botanists, and land protection specialists (to identify specific areas of high quality habitat, and the MNHESP Priority Habitat data layer (to identify known habitat for state and federally listed threatened and endangered species). As a result of this methodology, the “Final Focus Areas” represent large, minimally-developed areas of potential high-quality habitat(containing habitat for rare, threatened, and endangered species) and distinct landscape features, that are distributed across the watershed in a network that contributes to maintenance of landscape level ecological processes (Collins 2000).

Natural community and wildlife habitat inventories

As a follow up to the watershed scale analysis, the Mass Audubon Ecological Extension Service, under contract with the Nashua River Watershed Association and the Massachusetts Watershed Initiative's Nashua Team, conducted several studies -- “Natural Community and Wildlife Habitat Inventories” -- for discrete areas within the Nashua River watershed. These micro-level studies are good examples of the types of local inventories that might to be done to complement the macro-level Nashua River watershed focus area study. The combination of the regional assessment and the local inventories will provide an excellent understanding of the areas where actual critical habitat remains. Below is a description of the methods that were used to conduct the inventories.

There were five local inventories that were conducted by Jeffrey Collins of Mass Audubon Extension in 2002:

- Snake Hill area in Ayer and Groton
- Townsend Hill area in Townsend
- Muddy Pond and Whitney Hill area in Westminster and Ashburnham respectively
- Wright Ponds area in Ashby and Fitchburg
- Pine Hill area in Lancaster

Figure 2 shows the location of the five inventories within the Nashua River watershed.

Methods

The methodology summarized below is derived from the Natural Community and Wildlife Habitat Inventories (Collins 2002). When inventorying an area for its natural communities and wildlife, it is important to describe commonly found, typical conditions . However, it is equally important, if not more important, to identify features that are unique to the study area. Frequently, it is not the common species but the rare and unique occurrences that will attract attention to a parcel of land. Collect baseline information of your study area while searching for the unique facets of a study area.

The geology of New England provides an example. In some parts of New England (the White Mountains in New Hampshire, southeastern Maine, northeastern Vermont, and parts of northeastern Mass) much of the bedrock is igneous in origin, and the result is many overlying areas that have rather acidic soil conditions. There are other areas in New England (many parts of Vermont, western Massachusetts, and western Connecticut) that have metamorphosed sedimentary geological conditions and in these areas the calcium carbonate present in the bedrock will act to buffer the soil to a more neutral pH. Unique plant species and natural communities are often found on such areas due to the different soil conditions present. This example illustrates how the geology of an area can help identify potential unique natural communities and wildlife.

The approach used by Mass Audubon to conduct inventories involves three stages. The first stage involves reconnaissance of the study area using existing data sources and preparation for the field work. The second stage involves visiting the study area and conducting field work. The final stage involves collating all of the information that was discovered into a useful inventory document.

Stage 1 - Compile existing information and prepare for field work

Before ever setting foot in the study area, there are many sources of information available that will allow for more efficient inventorying of the study area. GIS maps are extremely useful in providing this type of background information. Visits to libraries that have descriptions or paper maps of certain physical characteristics of the study area can also be useful. Historical and cultural information relevant to the study area can also be researched at this time. At this stage of the inventory one must also contact property owners to ask for permission to conduct field work on private land. Organize your information gathering using the headings below.

Geological

The general bedrock geology of each study area is available from the bedrock geological map of Massachusetts (See Appendix IV). In addition, the US Geological Survey has compiled the bedrock geology for some of the topographic quadrangles in the state. The USGS website, http://ngmdb.usgs.gov/ngmdb/ngm_catalog.ora.html, provides access to these maps. The NH GRANIT GIS database has a statewide bedrock geology data layer. However, due to the scale of this data set (1:250,000) it is very generalized, and not appropriate for site specific analysis. MassGIS does not have a bedrock geology layer. Finally, the Harvard Geology Library in Cambridge, MA has paper maps of topographic quads.

Surficial geological information is available from a variety of sources. The US Geological Survey has topographic quadrangle maps of the surficial geology of some parts of Massachusetts. The MassGIS database has a surficial geology layer available for the entire state at the 1:250,000 scale. This surficial data is useful for locating deep sandy soils that can be of interest for the natural communities they support. The GRANIT database has surficial geology available at the 1:24,000 scale. This scale is useful for regional and town-wide analyses, but is not appropriate for parcel-level analysis. Looking at the surficial geology of a study area can alert you to the location of unique sandy deposits (vs. common till deposits) as well as dry site natural communities.

Soils

Look for anomalous soil types that are found only in a few places in the study area or region. For instance, some poorly drained areas will not qualify as wetlands. However, they may be home to unique natural communities and wildlife species. Another characteristic that often identifies unique soils is pH.

Soil surveys are available, county-wide from the USDA Natural Resources Conservation Service (NRCS) (See Appendix V). These maps are available at NRWA

River Resource Center. Some of the soil surveys are already available in digital format, but unfortunately, the surveys of Middlesex and northeast Worcester County are not yet available. They are currently being converted to digital format by the NRCS. In New Hampshire, the county-based soil survey for Hillsborough County is complete and available in digital format from the GRANIT GIS database.

Topography

In order to identify unique topographic features, use either a USGS topographic quad or a GIS Digital Elevation Model (DEM). If using the USGS topo quad, become familiar with interpreting contour lines on a map. Features of interest to identify are ridges, steep slopes, rocky outcrops, knobs, or anything that looks unique in terms of topography. Unique topographic features will often have physical features such as cliffs, talus, and outcrops that are associated with specific communities.

If a GIS DEM is available, use ArcView 3.x or ArcView 8.x with the 3D Analyst extension to analyse the study area. The 3D Analyst allows you to quickly pick out steep slopes, ridges, and knobs in a 3D depiction of the digital elevation model (DEM). There are other GIS tools available that can help identify unique topographical features. Ridges can be identified by finding all areas on a map into which water does not flow.

Hydrology

A variety of hydrological data layers are available from MassGIS that are helpful when preparing for field work in a particular study area. Visit the MassGIS and GRANIT websites to find a list of available hydrographic feature data layers (See Appendix V). Wetland location and type, floodplain location , as well as basic information such as stream and pond location are all available.

Connection to other areas

GIS is a very useful tool when trying to determine the connection of one study area to the surrounding natural areas. The following GIS data layers should provide useful information when trying to analyze the connectivity of multiple areas: Land use / Land cover, digital orthophotos (black and white or color), MNHESP BioMap (core habitat areas and supporting natural landscape). When analyzing landscape patterns, it is useful to simplify areas into “non-habitat” (residential, commercial, industrial, etc.), “potential habitat”, and “hydrological”. The patterns of connectivity are much easier to see using this over-simplified classification system. Sometimes land uses such as agriculture can fall in an intermediate category and are broken out separately.

Preparation for Field Work

Before conducting fieldwork in the study area, aerial photos were used to identify areas that should be visited. Current aerial photos provide a simple way to identify the different land use types. The time spent on distinct portions of the study area can be allocated accordingly. In addition to the various cover types, elements of importance also need to be located. The elements of importance were obtained through the interviews or through the use of MassGIS and MNHESP data layers. Contacting private landowners to obtain permission to visit their land is very important if private land exists within the study area. In all five of the Mass Audubon inventories, permission was obtained before walking the study areas. The specific landowners to be contacted were identified by the Nashua River Watershed Association and several GIS municipal parcel maps. With written permission granted from landowners, the distinct cover types identified, and the elements of importance located, the survey loops can be set. An access point must be identified where a vehicle can be left safely and the loop that will be traveled must be identified. Often, the fieldwork must be broken into several days of work. Each day will visit a different access point and survey a different loop in the study area. Finally, become familiar with the type of data that you will be collecting in the field. The data sheets that the Mass Audubon Extension use is included in Appendix XII. As you prepare for fieldwork, make use of the “cheat sheet” used by Mass Aububon Extension before setting out into the field. The Massachusetts Audubon Extension Service form is called the “Site/Forest Inventory Form” and can be found in Appendix XII. This will remind you of any equipment that you might need as well as alerting you to any pre-field work steps that you still need to take.

Stage 2 – Field Work

Sampling method

The equipment needed for such an inventory includes: Binoculars, Global Positioning System (GPS), digital camera, compass, map, hand lens, field guides, collecting material (ziploc bags, plastic vials, etc.), water proof field notebook, pencil, and an outdoor utility knife.

It is not recommended that permanent sample plots be established during this type of inventory. The fieldwork is meant to quickly identify the types of communities that are present and their location, as well as any unique species, natural communities, and landscape features that are present on the site. As one travels the loop that was decided on, periodic visual sampling should take place. The position of the sample should be noted on a USGS topographic map or by creating a waypoint with the global positioning system (GPS). Information on the canopy (if present), shrub species and ground species should be recorded. For the canopy species, the percent abundance, percent cover, and estimated canopy height should be noted. The shrub species present, their percent cover, and their relative abundances should be recorded. The ground species present and the percent ground cover should also be noted.

Natural Communities

Natural communities were identified using the MNHESP draft "Classification of the Natural Communities of Massachusetts". This classification can also be applied in the New Hampshire portion of the Nashua River watershed. Field observations were made that allowed the identification of the natural communities present in each study area. Significant experience in plant identification is needed in order to make use of this classification system. Currently, there is not a digital data layer that reflects this natural community classification system. For more information on this system, contact Massachusetts Natural Heritage and Endangered Species Program (See Appendix V) or download the document from the website, http://www.state.ma.us/dfwele/dfw/nhesp/nhclass.htm.

Habitat and species use of habitat

The ability to detect species will vary greatly depending on the time of year that the inventory is being conducted. Table 2 below provides a few examples of the type of information available at different times of the year. Snow in winter allows for tracking of mammals that are otherwise difficult to identify. Conducting bird counts at the beginning of and during breeding season will yield many more bird identifications than after the season when calls are not as frequent. If sign of animals was found, it was noted and then described when summarizing the results of the inventory for each study area.

Table 2. Variation in wildlife information available throughout the year

Time of Year	Wildlife that can be detected
Late May / Early June	Breeding bird census (Males are most active during this period). However, some species, such as the woodcock nest even earlier and may be missed.
Spring	Vernal pool/breeding salamanders/frogs (although they can be identified by egg masses later in the year and invertebrate obligate

	species, live fairy shrimp can be collected whenever there's water, dessicated fairy shrimp and fingernail clam shells can also be collected once water is absent.)
Winter (after snow)	Tracking whenever snow conditions allow (although mud holds tracks in any season)
Any season	Tracking after a recent rain that will result in mud)
April / May	Spring ephemeral wildflowers
Spring / Summer / Fall	Creation of a full herbaceous plant species list requires repeated visits.

Existing recreation conditions

Some information on recreation conditions can be gleaned from GIS maps before the fieldwork has been initiated. However, the majority of observations on recreation conditions are made when conducting fieldwork (i.e.: signs of usage -- horse, bikes, parties, ATVs, fire pits, camping, etc. -- and the locations of suchwhether on trail, off trail, or near parking lots). When you encounter people ask them how they make use of the area and if they know how others make use of the area. If appropriate, contact those who live within the study area and ask them how open spaces are used.

Stage 3 – Collating the information into a document

After stage 1 and stage 2 are complete, all of the information must be presented in a way that makes sense and is useful to future inventories or research. Present the findings in a very interesting way with the help of GIS maps which might include:

- A context area or orientation map showing the study area's location in the wider region
- An aerial photo map with the boundary of the study area and several well known features like major roads and waterbodies.
- A shaded relief map created with the DEM depicting relative elevation changes and unique topographic features.
- A map of the natural communities present in the study area. This map will have to be derived based on the field observations and any existing vegetation data layers that are

available. Use the natural community names found in the MNHESP Natural Communities Classification.

- A map of the path that was taken when conducting fieldwork, the location where sampling took place, and any other important points visited during the site visits.
- Additional maps of the physical data layers are very useful. If high quality data is available create a map for soil, geology, hydrology, wetlands, etc. Other useful layers such as watershed boundaries can also be shown thoughone ought not put too much information on any one map.
- A map showing the landscape connectivity of the study area to other open space and undeveloped areas is very informative.

The text of the document should provide the following information:

- Description of the site, geology, soils, hydrology, recreational uses, each of the natural communities present in the study area, and the larger landscape (including connections to other natural areas);
- Any observations on wildlife habitat present in the study area; and a summary paragraph.
- The conclusion should contain a summary of the important findings gained during the inventory. The unique features that make the study area important should also be described. Threats to the natural communities of the study area can also be discussed in the conclusion or in a separate section if needed.
- Brief recommendations as to what further information is needed in this study area is also useful.

Detailed Natural Resource Inventories

After the basic natural resources inventory described in the Moderate Inventories section has been completed, more complicated natural resource studies can be undertaken if required. The components that are chosen will depend on the goals of the basic natural resource inventory. For instance, if the focus of the NRI is the water resources of a town, then additional time might be spent collecting information on the groundwater resources.

While the basic NRI is often GIS-based, the detailed studies may turn to specific research that is not spatial in nature. Many very useful studies were written prior to the advent of GIS and continue to be better sources of information on our natural resources than GIS maps. Many documents have been written describing the geological conditions of very specific areas. These descriptions can be very detailed, but are often not spatial.

Several examples of detailed inventory studies are given. These examples were derived from the University of New Hampshire Cooperative Extension document entitled, "Natural Resource Inventories: A guide for New Hampshire communities and conservation groups". There are many other detailed studies that can be included in a natural resources inventory. The selected examples provide a good idea of the amount of additional effort that is needed in order to complete these studies.

Floodplains

Floodplains store and slow water in the event of periodic floods. Having a good idea of where they are located is very important for town planners. The extent of the 1% or 100-year floodplain is the standard by which floodplains are delineated. Small floods occur relatively frequently and can be labeled as 1 or perhaps 5-year floods. Large floods occur relatively infrequently. Statistics can be used to determine how large a flood would be that occurred once every 100 years. A 100-year flood is the level of flooding that has a one in 100 or 1% chanceof happening in any given year.

Maintenance of floodplains in their natural state is the cheapest and most effective way to insure that they protect from potential flooding not only your town but areas downstream. Floodplains have been identified by the Federal Emergency Management Agency (FEMA) and the US Department of Housing and Urban Development using the 100-year floodplain.

Once acquired, the FEMA floodplain maps can be used to determine whether appropriate land uses are present within the boundaries of the flood plain. The floodplain could be used to determine if structures have been built in the 100-year floodplain and if protective measures are needed. In addition, the 100-year floodplain could be the basis for a flood protection overlay district that is incorporated into local bylaws. Please refer to the Municipal Bylaw Database that was compiled and is available at the NRWA River Resource Center.

The FEMA Flood Insurance Rate Maps (FIRM) data layer is available from MassGIS for all counties except Franklin County. In New Hampshire 200 communities have digital FEMA maps that can be accessed.

Wetland evaluation and prioritization

Wetland evaluations are conducted on wetlands in order to determine their ability to perform any of a number of beneficial functions derived from wetlands. Prioritization entails determining which wetlands have values that are derived from other resources that co-occur with the wetland, such as a stratified drift aquifer or habitat for a rare species.

Evaluation and prioritization cannot always be completed with the help of GIS. Site visits and additional fieldwork will often be necessary in order to complete evaluations and prioritizations. Given the emphasis on the protection of wetlands and water resources in both New Hampshire and Massachusetts, this detailed inventory study is frequently a section in natural resource inventories.

Contact your local conservation commission to determine if an evaluation or prioritization has been done for the wetlands in your area.

Other useful publications that describe wetland studies include, “Study Guide to New England’s Freshwater Wetlands”, “The Municipal Guide to Wetland Protection”, and “Delineating bordering vegetative wetlands under the Massachusetts Wetlands Protection Act”. See Appendix IV for the full references.

Wildlife habitat

While some inventories may focus on the hydrological resources, other natural resource inventories will be driven by the identification of important wildlife habitat. In terms of wildlife, much of the emphasis of federal and state environmental legislation is placed on the protection of individual species that are rare or threatened. An increasing amount of attention is being paid to entire ecosystems or natural communities as well. Protection efforts are increasingly focused not only on individual species, but on entire ecosystems or natural communities.

In addition to conducting a basic natural resource inventory as described in the Moderate Inventories section, citizens groups should consider completing micro-level wildlife habitat inventories These studies are described above and can serve as excellent ways for local land trusts, citizens groups, and conservation commissions to prioritize lands for acquisition and protection. They will also create a baseline source of information on the wildlife of your area.

The MNHESP recently completed BioMap of “core habitat” areas and “supporting natural landscape” is also a very good source of information on important wildlife habitat that might be considered for protection.

Another source of information on wildlife habitat studies is “Identifying and Prioritizing Significant Wildlife Habitat: A guide for New Hampshire communities and conservation groups”. For complete references please see Appendix IV.

Historic and archaeological resources

The last example of a detailed inventory study examines historic and archaeological resources which may be present in your study area.

Historical use of our natural resources can still be seen today in all areas of New England. Stonewalls are seen everywhere in New England in areas that have been reforested. Homes foundations can be found as well as for mill sites. All communities have historic buildings.

There are many sources to turn to when researching the historic resources of your town. Data from the National Register of Historic Places can be found from both the GRANIT database for New Hampshire and from MassGIS. In Massachusetts, this layer contains listings from before 1997 only. For a complete list of historic buildings, an up to date State Register of Historic Places can be purchased from the State House bookstore. Local historic societies are great sources of information as well. Old tax records will often provide information on land uses as well as where buildings used to stand.

Investigating the archaeological resources present in your area is a challenge because of the sensitive nature of this type of resource. The location of archaeological resources are often generalized so they are not vandalized or damaged by curious citizens. In NH archaeological information can be acquired from the State Archaeologist's office in the NH Division of Historic Resources. In Massachusetts, contact the Massachusetts Historical Commission.Other detailed inventory studies that could be undertaken include, but are not limited to: favorable gravel well analysis, active farmlands, forest resources, undeveloped shorelands, scenic resources, recreation resources, and unique geologic resources. For a description of these studies, please see "Natural Resource Inventories: A guide for New Hampshire communities and conservation groups".

Habitat inventories for selected species

Habitat Evaluation Procedure

The Habitat Evaluation Procedure is a model designed by the U.S. Fish and Wildlife Service (USFWS). It allows the user to assess habitat quality based on the habitat's ability to support a specific species or group of species. The model typically is used to evaluate proposed projects and determine any necessary mitigation measures that need to be taken. For more information contact your state office of the Fish and Wildlife Service.

GIS based analysis of habitat and natural resources

Once a high quality GIS data base has been compiled for your study area, there is really no limit to the types of sophisticated analyses that can be done using the GIS and its analytical capabilities. Several possible analyses are described below. There are many other types of assessments/inventories that can be done with GIS that are not described herein.

University of Massachusetts Conservation Assessment and Prioritization System

The Conservation Assessment and Prioritization System (CAPS) is a computer software program designed by a group of researchers at the University of Massachusetts, Department of Natural Resources Conservation (http://www.umass.edu/landeco/research/caps/caps.html). It is designed to evaluate the biodiversity value of all locations across the landscape based on natural community specific models, prioritize lands for conservation based on their value, and also take into account other information relevant to prioritization.

The software program is not yet available online. However, there are slide shows and more detailed descriptions of the program on the website.

CAPS is a program that is available that helps individuals and organizations prioritize conservation efforts based on information that is provided about biodiversity. A high level of technical expertise is required to use this program as it requires use of multiple GIS data layers, the ability to manipulate large amounts of output from the program, and a strong background in natural resources and wildlife ecology. Please consult the above website if interested in this program, or contact the Principal Investigators that are also listed on the above website, Dr. Kevin McGarigal, Scott Jackson, and Dr. Curt Griffin.

Gap Analysis

Gap analysis is another method that identifies high priority areas for conservation efforts. It makes use of maps to compare ecosystem types and other elements of biodiversity with current land ownership and management status. Land ownership and management status provides information on the areas that are protected (such as parks, refuges, or preserves). Overlaying the biodiversity information with the information on protection status allows the identification of areas that are not currently protected. This analysis thus pinpoints the areas where further conservation efforts should be guided. The U.S. Fish and Wildlife Service is conducting a large-scale state-by-state Gap Analysis project using satellite imagery, other data on vegetation and GIS mapping.

Although the USFWS Gap analysis project is being conducted for each state, the methodology can be used at any scale, from national to local. A Gap analysis was conducted for Southern New England, including the states of Massachusetts, Connecticut, and Rhode Island.

In order to conduct a Gap analysis, a high level of GIS expertise is needed. In addition, the ability to model biodiversity is needed. On a regional scale, this will often mean modeling all of the vertebrate species within an entire region. However, for a local Gap analysis, the analysis could incorporate point information for key species or rare species as well as other pieces of information such as the location of large natural pieces of habitat.

Aquatic

There are many advanced habitat assessment techniques for rivers and streams that can be undertaken by experienced citizens. They are very similar in nature to the inventories described in the Moderate Inventories section. However, they go into more detail and require much more knowledge of methods. For more information on these types of assessments, contact Martha Morgan of the NRWA at (978) 448 0299. Described below are several advanced monitoring techniques that can be established for wetlands.

Rivers/Streams

State, Federal, and local River and Stream Assessment Programs

If interested in conducting a complex aquatic inventory, it would be best to contact one of the established state, federal, or local groups that are familiar with these types of inventories. Programs of the Massachusetts Department of Environmental Protection (DEP), the US Environmental Protection Agency (EPA), and the Nashua River Watershed Association are briefly described below.

The Massachusetts DEP includes bioassessment as a component of the State's watershed-based water quality management program. DEP biologists conduct habitat assessments and biological sampling to supplement other water quality monitoring and management programs. For more information on making use of DEP standards for water quality contact the appropriate DEP office (see Appendix V).

The US EPA uses the Rapid Bioassessment Protocol (RBP) to monitor the health of streams and rivers. RBP samples are collected at monitoring sites for upstream-downstream comparisons, comparisons to regional or surrogate reference locations, or for long-term trend monitoring at fixed locations. Two different levels of bioassessments are employed (RBP II or RBP III) depending on survey objectives.

The RBP includes macroinvertebrate assessments in its methodology. Macroinvertebrate data are used to supplement traditional physicochemical analyses by demonstrating biological impact as well as assessing water quality and habitat conditions. The bioassessment results in an overall impairment rating that ranges between nonimpaired to severely impaired.

Nashua River Watershed Association Water Quality Monitoring

The Nashua River Watershed Association has had a water quality monitoring (WQM) program since 1993 with the intent of building baseline information to track trends and identify "hot spots" for remediation. The program is based on the US EPA Bioassessment Protocols established for Volunteers. A Quality Assurance Project Plan (QAPP) has been prepared to help standardize collection and processing procedures. Volunteer monitors collect up to 40 water samples on a monthly basis from April through October.

In 2002, the Devens Earth Tech water treatment facility and the Pepperell Wastewater Treatment plant are our testing laboratories. Monitors deliver their water samples to the labs, where trained volunteers and / or municipal treatment plant personnel analyze the samples.

Samples have been routinely analyzed for the following parameters: pH; Temperature (in situ); Alkalinity; Dissolved Oxygen; Fecal Coliform; Total Coliform; and, E.Coli (in New Hampshire, and occasionally at other sites, as a subset of Fecal Coliform). Phosphorous concentrations are also being monitored beginning this year, 2002.

In 2000, monitors also sampled benthic macroinvertebrates in order to have a direct indicator of the river's health.

Overall, program results have shown that the water quality is generally good. Volunteers have been closely watching some sites with consistently high fecal coliform and some tributaries that are affected by sedimentation. In addition, we are concerned about trends toward continued loss of riparian buffers on tributaries, increased flow of treated effluent and septic leachate, increased withdrawal from surface and groundwater sources, and increased impervious surface area.

For instance, sites along the river in Lancaster have had elevated fecal coliform counts in recent years. Recently the town of Lancaster has decided to create a sewer system for the downtown portion of town. The NRWA monitors are now poised to see if this improvement of the municipal infrastructure will have a significant impact on the levels of fecal coliform bacteria.

If you are interested in becoming a Volunteer Water Quality Monitor or if you have questions about water quality issues, please call Martha Morgan, NRWA's Water Resources Advisor or e-mail mmorgan@NashuaRiverWatershed.org

An intensive invertebrate assessment involves the collection and preservation of the species that are collected. They are brought to a lab where identification is made as accurately as possible, mostly to the family level. With this additional level of accuracy, calculations for the total numbers, diversity, pollution tolerance, feeding ecology, and community composition can be made. As before, the impact sites are compared to reference sites and the site is considered not impaired, moderately impaired, or severely impaired.

For information on the courses described above, contact the NERMC at (413) 545 5532 or visit the website http://www.umass.edu/tei/mwwp/nermc.html.

New England Regional Monitoring Collaborative

The NERMC also offers courses in Intensive Benthic Macroinvertebrate Assessment. A significant amount of experience with invertebrate identification is needed which is why the course was placed in the Complex Inventory section. An intensive invertebrate assessment involves the collection and preservation of the species that are collected. They are brought to a lab where identification is made as accurately as possible, mostly to the family level. With this additional level of accuracy, calculations for the total numbers, diversity, pollution tolerance, feeding ecology, and community composition can be made. As before, the impact sites are compared to reference sites and the site is considered not impaired, moderately impaired, or severely impaired.

For information on the courses described above, contact the NERMC at (413) 545 5532 or visit the website http://www.umass.edu/tei/mwwp/nermc.html.

Wetlands

Level III wetland monitoring

A level III monitoring effort as described by the "Handbook for Wetlands Conservation and Sustainability" should be initiated only after a level II effort was undertaken. It entails more intensive monitoring of individual species or components. This additional level of monitoring requires technical expertise and additional funding for equipment, laboratory fees, and volunteer training. If this knowledge base is not already present in your Steering Committee, additional time and funding will be required to enroll in necessary courses.

The studies that are undertaken for level III inventories are often unique to the wetland of interest. For this reason, no additional forms were provided by the Izaak Walton League of America in addition to the level I and II forms. Several different types of monitoring efforts are described here. However, many other level III studies are possible. Several potential components of a level III effort are described below.

Crest/Staff Gauge Installation

A crest/staff gauge can determine the depth, frequency, duration, and inundation pattern of a wetland. It can be set up in about an hour with an experienced hydrologist.

Piezometer Installation

You may require a permit to install piezometer wells, which are small, narrow holes almost three feet deep. Piezometers are used to get a better idea of the annual cycle of saturation of wetland soils. You can determine if a wetland is saturated year round or only seasonally, if the wetland is supplied by groundwater, and if the wetland is a groundwater recharge area. Interpretation of the piezometer requires some experience and it is recommended that a hydrologist be used.

Reptile and Amphibian Trapping

Sometimes setting up reptile and amphibian traps provides useful information on the species present in your wetland. There are a variety of trap set ups that can be used such as drift fences with pitfall traps. Attention must be given to the intervals between which the wetland is visited in order to minimize trapped animal mortality.

Chemical monitoring project

Chemical monitoring is a task that should not be undertaken without significant commitment to time and funding for such a project. The group should be clear as to why chemical monitoring will be undertaken, which chemicals will be monitored, and why. If large amounts of fertilizer are used in the watershed, sampling nitrogen and phosphorous will likely provide useful results.

High levels of technical expertise are required to collect and process samples in an accurate manner. Enrollment in classes is one way to gain the experience necessary to collect and process samples. Local universities, and local state and federal monitoring programs may also have some time to provide guidance in the initial stages of project set up.

Finally, schedules should be considered before initiating monitoring. Ideally, chemical monitoring should be done weekly. Very useful information can also be gleaned about wetlands after storm events, when rainfall runoff pollution can be detected. Finding volunteers that have flexible schedules to monitor after storm events is important.

Additional monitoring techniques described by the Izaak Walton League of America include fish sampling and macroinvertebrate sampling. For additional details on these techniques as well as those described above, see the "Handbook for wetlands conservation and sustainability" referenced in Appendix IV. For more information on and to order the Izaak Walton Leage of America "Handbook for Wetlands Conservation and Sustainability" visit the following website: http://www.iwla.org/sos/handbook/.

Wetland Evaluation Technique (WET)

The WET model is supported by the U.S. Army Corps of Engineers. It provides a broad assessment of ecosystem health. Once the model is learned, it can provide consistent results showing the functions that are supported by local wetlands.

Appendix II – Examples of inventories in the nashua river watershed

Preliminary Ecological Assessment of the Webber Properties and Wharton Plantation, Groton, Massachusetts

This ecological assessment was prepared for the New England Forestry Foundation (NEFF) by Bart DeWolf (DeWolf 2002). It focused on the three Webber Family properties (Gibbet Hill, Angus Hills, and Brooks Orchard; totaling ~450 acres) and a portion of NEFF's Wharton Plantation (~210 acres). The ecological assessment, conducted in June and July of 2002 in the Town of Groton, MA, was conducted to investigate the ecological significance of each property in the context of its surrounding landscape.

The assessment made use of the following information:

- Groton Open Space and Recreation Plan (Groton Conservation Commission 1998)
- 2020 Planning Documents (Groton Planning Board 2002)
- Groton Conservation Trust conservation lands map (Groton Conservation Trust 2000)
- title (Collins, MAS, 2000).
- MassGIS data including: 1995 aerial photos; USGS topographic maps; Cultural features ; Hydrographic features; Political boundaries; Nearby conservation lands; Wetlands data; and, Massachusetts Gap Analysis Program (GAP) vegetation data
- Classification of the Massachusetts Natural Areas Program (Swain and Kearsley 2000)

Initial site visits were made while accompanied by those familiar with the properties . Two days were spent gathering field data on the main physical and natural features of the properties, and looking for unique terrestrial or aquatic communities. The final report includes a description of the naturaland cultural communities, wildlife sightings and sign found on the properties, maps of the community boundaries, a plant and animal species list, photographs, and other relevant maps. In addition, there was also a discussion of the ecological features and their placement in the regional landscape (landscape connectivity).

This type of assessment is meant to be a preliminary study of the natural and cultural resources that are present on a property. Subsequent studies will be able to jump off from this starting point in order to conduct detailed studies of the natural communities, plants, animals, and cultural features located on the property. While useful to alert landowners of important species and communities that are present on the land, this level of assessment is not sufficient to evaluate the change of an area over time. This level assessment is best followed by further studies including a winter tracking program, a surveys of small mammals, amphibians, reptiles, and breeding birds.

Wildlife Habitat Analysis and Inventory of the Groton Place, Groton, Massachusetts

This wildlife habitat analysis and inventory was prepared for the New England Forestry Foundation (NEFF) by Tom Brulé of New England Forestry Consultants, Inc. in the summer of 1999. It was conducted to help NEFF determine which wildlife species were present on the Groton Place and evaluate various land management possibilities given its current condition. the Groton Place is located where Route 225 crosses the Nashua River, on the southeast corner of this crossing.

Current relevant documents were reviewed. Conversations were held with experts and citizens knowledgeable about the area. Two site visits were made to Groton Place as well as to abutting land. During these visits attention was paid to scat, pellets, skulls and bones, natural communities present, as well as wildlife sightings and bird call identifications. Wildlife species potentially present on the site were determined by cross-referencing "New England Wildlife: Habitat, natural history, and distribution" (DeGraaf et al. 1983) with the habitat types and characteristics that exist in the area.

The final report includes a description of the five major habitat types found on Groton Place, a discussion of the management history and potential future management options, as well as basic animal and herbaceous species lists.

The emphasis of the document was not on mapping the layout of the property. Instead, it focused on a discussion of various management alternatives and supplemented this discussion with basic information on the natural communities and wildlife species present. This is a good example of a simple inventory that can begin a dialogue about various management strategies that are available to a landowner, or other land stewards.

The Groton Place, Groton, Massachusetts

The Groton Place is a short inventory that was prepared by Hugh T. Putnam, Jr in 1975 for the New England Forestry Foundation. It concentrates on The Groton Place, the same area inventoried in 1999.

The brief document is but a physical description of the parcel. The document includes a brief description of the primary tree species present along with a brief description of the ornamental plantings, trail system, and maintenance of the property. A short section is devoted to the multiple-use potential of the parcel and other management options. Finally, a list of recommendations and a brief budget to implement the management options summarize the findings in the report.

This report is very brief but highlights the importance of regular inventories being conducted on properties. Although there is very little detailed information in the document, it describes a parcel that had been very heavily managed (i.e.: many ornamental species, many trails). This is one potential management option for the property that may have been forgotten in the absence of this report.

Botanical Inventory of Futterman / Haynie Property, Ashby, MA

Al Futterman and Deirdre Haynie retained Frances Clark of Carex Associates to conduct a botanical inventory of their 45 acre property in Ashby, MA. The botanical inventory lists the species identified by community type and provides basic descriptions of the natural communities present on the site: red maple swamp, mixed deciduous forest, and hemlock stands. The inventory took place on August 9, 2002 and took six hours to complete.

The inventory began with a site visit with the property owner and then was followed by six hours of field work. The property was traversed several times and separate lists of plant species were kept for each of the natural community types present. The report is brief due to the brief nature of the inventory and contains an overview of the inventory, community descriptions, and a list of plant species that were found on the property.

This inventory was partially funded by a Stewardship Incentive Program (SIP) grant available through DEM's Forest Stewardship Program. The inventory educates the landowner about plant species that are present, enhances the landowners ability to enjoy and understand their property, suggests stewardship plans for the property, complements tree focused forest inventories, provides useful information to the Mass Natural Heritage and Endangered Species Program, and provides a baseline against which future inventories can be compared.

Forest Management Plan, Town of Shirley

This Forest Management Plan is just one example of many plans that have been completed in the Nashua River Watershed. Municipalities can create Forest Cutting Plans under chapter 132 of the MGL. Private landowners can create plans under Chapter 61A and qualifty for significant property tax reductions. The Nashua River Watershed Association has a database of many properties that have Chapter 132 Forest Cutting Plans in place. The town of Shirley Conservation Commission prepared a Forest Management Plan in 1999 for the 111 acre Rich Town Forest.

Chapter 61 & Chap 61A allow all parcels of greater than ten acres and five acres (respectively) that are in "forest production" to be classified as "forest land". This can significantly reduce the taxes assessed on such classified parcels. Application for such a classification must be accompanied by a Forest Management Plan that must be reviewed by a state DEM service forester. The requirements of Chapter 61 are more restrictive than the requirements of Chapter 61A. Under Chapter 61A, the 8% stumpage tax is not required. Some service foresters are more willing to allow a parcel to be considered under 61A, rather than chapter 61.

The FMP briefly considers the management objectives for the parcel given the types of habitat, recreation, forest products, and soil and water potential that exists on the parcel. The regional context of the parcel is also considered. The majority of the report is devoted to an inventory of the different stands located within the parcel. The species present, size, volume of wood, quality of the wood is evaluated and the stand is then briefly described. Management recommendations are made for each stand.

The Nashua River Greenway – Pepperel Pond Area

Nancy L. Nielsen prepared this inventory in 1979 for the Rich Tree Farm Task Force which was comprised of the Groton Conservation Commission, the Pepperell Conservation Commission, the Groton Conservation Trust, The Nashoba Conservation Trust, and the Nashua River Watershed Association.

The inventory was requested by the Rich Tree Farm Task Force to further the potential acquisition of the Rich Tree Farm in Groton as a State Forest by the DEM and the EOEA. The inventory also covered the land surrounding Pepperel Pond because of its enormous recreational potential and existing wildlife habitat.

Plant species were inventoried by randomly placing 100 square meter plots onto a USGS map that included the study areas and recording the tree species present. Additional information on wildlife species was also recorded during site exploration. This inventory was summarized with tables and species lists.

If the original sample plots were appropriately marked, it would be possible to conduct a current survey and track how the species composition has changed on the site. Even in the absence of such information, this inventory is still a great example of valuable baseline information.

Natural Resource Management Plan, Beaver Brook Association, Hollis, New Hampshire

The Beaver Brook Association completed a natural resource management plan to create guidelines for the conservation, use, and management of the natural resources of property. The 1999 plan -- completed under the guidelines of the Stewardship Incentive Program (SIP)

--focuses on the approximately 1670 acres of land located in the southern New Hampshire towns of Hollis and Brookline and will guide management practices for ten years to come. Embedded in the management plan is an inventory of Beaver Brook Association land's natural resources, which was then used to inform the management plan developed in the document.

The natural resources inventoried include: scenic, recreational, historical and cultural, water, soil, agricultural, forest, wildlife habitat, wildlife species, natural and wild area, endangered and threatened species and communities, and Beaver Brook Association land's regional importance. The baseline information on these resources was used to create management recommendations for: access, scenic values and recreation, historical and cultural features, water quality and resources, dam management, agricultural uses, forest harvesting, wildlife habitat, natural and wild areas, natural and endangered species and communities, and regional land conservation and long term land protection.

Natural Resource Section of the 1998 Master Plan, Hollis, New Hampshire

The town of Hollis, New Hampshire created its original master plan in 1971. Since then five more updates have been created including the 1998 Master Plan. This latest Master Plan is a policy statement for guiding local land use regulation, transportation improvements, environmental protection, and capital improvements from 1998 to 2008. A natural resource inventory was included as a component of the master plan because of "great concern and attention by residents of the Town on preservation and protection of the diverse natural resource base." (Hollis Master Plan, pg 4, 1998)

The outline of the Natural Resources chapter is included below as it is informative. Hollis placed much emphasis on the water resources portion of the document given the strong interest and concern conveyed by town residents. The focus of a natural resource inventory will change given the local resources and the local concerns that are voiced by citizens. The inventory is not exhaustive in all of the selected categories but instead focuses on the resources that are most important to town residents.

- Topography
- Soils
- Soil potential for development
- Important farmland soils
- Water resources
- Watersheds

- Perennial streams
- Floodplains
- Recreational zones
- Lakes and ponds
- Silver Lake study, 1986
- Flint's Pond study, 1997
- Wetlands
- Prime wetlands
- Ground water
- Wildlife
- Animals and birds
- Plants
- Conservation lands
- Visual resources
- Potential threats to natural resources
- Natural resource recommendations

A useful table and accompanying map was included in the conservation lands section describing the "Priority areas to conserve". Each area was located on the map of the town and the type of resource it represented was noted (forest, wildlife, viewscape, etc.). The recommendations section went through each of the above natural resources and listed what could be implemented to help protect resources as well as the responsible town entity.

Appendix III –Focus areas

Large focus areas

There were 9 large focus areas identified by the analysis that include roughly 28% of the watershed. Each of the areas is over 7000 acres in size of which only a tiny amountis disturbed habitat. The areas are large enough to contain species that are otherwise sensitive to human disturbancealthough all of them contain roads that to some extent penetrate into their interior. The descriptions of the focus areas below were taken directly from the Mass Audubon focus area report.

Mt. Wachusett/Hubbardston Wildlife Management Area (18,816 acres)

Located in Princeton, Westminster, and Hubbardston, this very large area of little-developed land sits on the southeastern corner of the Worcester Plateau ecoregion. Although it lies mostly outside the Nashua watershed, its position at the southern end of a ridge line extending into New Hampshire, its elevation and topography, and its importance to natural communities typically found to the north make it one of the most important habitat cores in this analysis. Uncommon and high-quality natural communities include "Spruce-Fir-Northern Hardwood Forest" and "Acidic Rocky Summit/Rock Outcrop" (although this example is impacted by a parking lot and foot traffic).

At least 32% of the area is permanently protected, with an additional 14%, in the areas around Wachusett Lake, Meetinghouse Pond, and Mare Meadow Reservoir, listed by MassGIS as open space with unknown protection. The major conservation properties are the DEM Wachusett Mountain State Reservation, DFWELE's Hubbardston WMA, and Mass. Audubon's Wachusett Meadows Wildlife Sanctuary. Priority habitat areas are almost completely contained within these protected lands. The Midstate Trail runs along this ridge. Recent building along New Westminster Road in Hubbardston has reduced the amount of interior habitat.

Badger Hill/Spaulding Brook (12,200 acres)

This area in Mason, Brookline, Wilton, and Milford, New Hampshire features diverse topography with Spaulding Brook, Mitchell Brook and smaller streams cutting through a series of steep-sided valleys between Boynton, Burns, Badger, Hutchington, and Pale Hills. These steep slopes could include ledges with talus fields below, which often host uncommon natural communities. The uplands adjacent to the brooks are crucial to the maintenance of these feeders to the Nissitissit as clean, cold-running habitat for aquatic invertebrates and native fish populations. The north-facing slopes of these hills likely harbor natural communities , such as Spruce-Fir-Northern Hardwood Forest, more common to the north and found in few other places in the Nashua watershed. Badger Hill/Spaulding Brook serves as a habitat core, and together with the Townsend State Forest focus area, offers a wide corridor for wildlife moving north.

The focus area appears to be relatively undeveloped, yet only 5% is permanently protected according to New Hampshire GRANIT data. The steep valleys and limited lowland adjacent to streams means that there are few wide marshes or swampy areas, but the many saddles and areas of gentle slope may be sites of vernal pools.

Leominster State Forest (11,301 acres)

The largest area of contiguous undeveloped land located wholly in the watershed, the landscape centered on Leominster State Forest is an absolutely crucial piece of any effort to maintain core wildlife habitat in the watershed. With a tremendous diversity of large water bodies, such as Notown and Fall Brook Reservoirs, and Hy-Crest Pond, several medium and small open ponds, extensive wetlands at Bartlett Swamp and south of Notown Reservoir, and the topography of Ball and Crow Hills in the west and the Monoosnuoc Hills in the east, this focus area should be one of the highest priorities for concerted land protection in the watershed. The water bodies are of particularly high value for their undeveloped perimeters; such areas may serve as nesting habitat for Common loon, a species of special concern. Three prominent ridges – Snow Hill-Crow Hills, Palmer Hill-Ball Hill-Wolfden Hill, and Monoosnoc Hills-Bayberry Hill – reach off of the Worcester Plateau providing an upland connection in the southwest to the Mt. Wachusett focus area and the Wekepeke Brook area to the south. Perhaps the best example of an acidic talus slope in the watershed is found at base of cliffs on the eastern slope of Crow Hills.

Leominster State Forest itself accounts for 32% of this focus area in permanent protection. The Town of Leominster and others own an additional 12% of the area with level of protection listed as limited or unknown by MassGIS.

Mt. Watatic (10,692 acres)

Although the focus area lies entirely outside of the Nashua River Watershed, it is mentioned as a priority of the Ashburnham and Ashby Conservation Commissions. This large area is a natural extension of open space running north from Savage Hill in Rutland and relates to the value of Mt. Hunger/Russell Hill and Upper Naukeag/Lincoln Pond as connectors of large habitat areas.

Wachusett Reservoir (10,339 acres)

Clearly an important habitat resource as the largest body of open water in the watershed, Wachusett Reservoir is nonetheless a focus area of a different variety. Metropolitan District Commission (MDC) holds 36% of the land within this focus area in addition to the surface of the reservoir itself. The reservoir is important habitat for lake-nesting and -feeding birds. The entire water surface with adjacent upland connects with the Stillwater River in one large MNHESP Priority Habitat area.

Savage Hill WMA/Quinapoxet Reservoir (9,124 acres)

This long, narrow focus area stretches along the Princeton-Rutland line into Holden, from Savage Hill in the northwest to the Quinapoxet Reservoir and Maple Spring Pond in the southeast. Mushcopauge Brook, especially at Holbrook Swamp is a protection priority, as are the extensive wetlands with adjacent uplands on either side of Glenwood Road south of Davis Hill. This focus area is a connector between the expansive open space of Mt. Wachusett to the north, the Pine Hill Reservoir focus area to the south, and the Poutwater Pond focus area to the east. Savage Hill WMA, MDC, and Worcester Water Department lands combine with APR lands to total 42% of this area.

Townsend State Forest (8,698 acres)

This focus area with parts in Townsend, Mason, and Brookline straddles the state line in the north-central section of the watershed. While the Massachusetts portion is almost 100% permanently protected as Townsend State Forest, it appears that very little land on the New Hampshire side is protected in any way. The area abuts the Badger Hill/Spaulding Brook area in the north, and these two well-connected core areas allow wildlife movement well into the watershed from the less developed areas further north in New Hampshire. Barker Hill and uplands to the east may be another important wildlife corridor as they form a ridge dropping off of the Worcester Plateau . Uplands include rocky outcrops that provide high quality habitat for snakes, and support headwater streams of the Nissitissit and Squannacook Rivers.

Oxbow/Intervale/Bolton Flats (8,476 acres)

Like Leominster State Forest to the west, this large focus area, together with McGovern Brook and Ballard Hill focus areas, is a wildlife habitat anchor in the east-central section of the watershed. Located in Lancaster, Harvard, and Bolton, the protected and largely trail-less Oxbow NWR and Bolton Flats WMA, and restricted-public-access Devens South Post create what could be the largest, least human-impacted habitat in the watershed. Even with military training in the South Post, the lack of buildings, low traffic, and periodic nature of human presence on the property mean that animals move relatively unmolested across this landscape. Tracks of bobcat, black bear, and moose have been recorded within this focus area. Bobcat are particularly sensitive to human disturbance and their presence in an area is a very strong indicator of high quality habitat. The “drop zone,” a large grassland maintained through mowing and occasionally used for parachute training, and the “impact zone” used for mortar training are two very important, uncommon habitat types. The maintained grasslands of the drop zone are utilized by upland sandpipers (endangered in Massachusetts), vesper and grasshopper sparrows (threatened in Massachusetts), and savannah sparrows, a species of special concern. Pitch pine woodlands and adjacent openings host one of the largest whip-poor-will populations in the state, and the frequently-burned scrubby cover of the impact zone is habitat for brown thrashers, another species in statewide decline. These are the largest, highest quality grassland habitat and pitch pine woodland habitat in the watershed. Nineteen listed species have been identified in a MNHESP Priority Habitat polygon that is almost entirely enclosed within this focus area. Uncommon plant communities include Pitch Pine/Scrub Oak Barrens around impact zone, an alluvial red maple swamp, small river floodplains, and bogs.

The clear protection priority in this focus area is the continued and long-term management of Devens South Post in ways that are conducive to maintaining wildlife habitat.

Lake Wompanoag (7,265 acres)

The area in the vicinity of Lake Womponoag in Ashburnham, Gardner, and Winchendon is one of the largest pieces of contiguous open space in the watershed; and the lake itselfis one of the largest relatively undeveloped water bodies in the watershed. More than half of the area we have highlighted as important habitat lies outside the Nashua Watershed, but this entire undeveloped expanse is important for its size, its large amount of interior, and its location on the western edge of the watershed, lying in the Worcester Plateau ecoregion. Due to its higher elevation than most of the watershed, this area hosts natural communities, such as Spruce-Tamarack Bogs, that have northern affinities and are found here in the southern part of their range. It should be considered another cornerstone of a reserve design for the Nashua River Watershed.

Though there is low-density residential development to the southwest of Lake Wompanoag, and there are camps and a small lakefront community on the west side of the lake, the area is largely undeveloped. The entire lake is identified as Priority Habitat by the MNHESP. Part-time resident Elizabeth Bagdonas has conducted extensive biological inventory of the area focusing on the high-quality bog at the northern end of the lake. To the north is Cheshire Pond and another extensive boggy wetland, also identified as Priority Habitat. This wetland system, though not connected hydrologically, likely serves as an ecological link for animals requiring wetland habitat. Populations of bog-loving plants also benefit from this large system of acidic wetlands. The area is criss-crossed by a discontinued road and an old railroad bed as well as a power line right-of-way, all of which serve as feeding habitat and movement corridors for larger mammals, invertebrates, and birds. They are also used by all-terrain vehicles and motorcycles, with potential impacts on wildlife.

A significant portion of the area – 26% -- is permanently protected, primarily under ownership of Mass. Audubon Society, DEM, and the Town of Gardner. Important targets for habitat protection include all of the Priority Habitat areas, especially undeveloped shoreline on Lake Wompanoag

Medium-sized Focus Areas

The 10 medium-sized focus areas comprise 13% of the watershed. While these areas are smaller than the large focal areas, they can still provide home range for a large number of species. The descriptions of the focus areas below were taken directly from the Mass Audubon focus area report.

Birch Hill/Rocky Pond (6,866 acres)

Like Badger Hill/Spaulding Brook, this focus area is important for its topography, position at the northern end of the watershed, connections to other large areas and the Nissitissit River corridor, and protection of steep, first order streams such as East, Stonehouse, and Rocky Pond Brooks. Again, typical of the abruptly rising hillsides in this northern part of the watershed, there are few large wetlands; however the north-facing slopes should be investigated for uncommon natural communities. Much of Rocky Pond Brook is protected by the Beaver Brook Association.

East Wachusett & Wekepeke Brooks (6,439 acres)

Difficult to label, this oddly shaped focus area ties together extensive lands with limited protection along East Wachusett Brook in its western end, unprotected habitat in its center, and additional protected lands around Fitch, Lynde, and Spring Basins adjacent to Wekepeke Brook. Keyes Brook, a tributary to the Stillwater running northwest from West Sterling, is part of the MNHESP Priority Habitat area that connects down the Stillwater River all the way to Wachusett Reservoir and is habitat for numerous listed turtle species. The area is not without some development, yet it is an important connector between the extensive habitat of the Leominster State Forest and Poutwater Pond focus areas.

Pine Hill Reservoir (5,714 acres)

Exceptional for the extent of undeveloped hillside directly adjacent to large bodies of water, this focus area in Rutland, Holden, and Paxton forms the southern extent of a string of open areas stretching north to Mt. Watatic and beyond. The area around the reservoirs is known to provide excellent snake habitat, and the wetland to the west of Bond Hill is a MNHESP Priority Habitat. Twelve percent of the area is listed as permanently protected by MassGIS.

Poutwater Pond (5,700 acres)

This focus area in Princeton, Holden, Sterling, and West Boylston is centered on property owned by Metropolitan District Commission (MDC), Department of Fisheries, Wildlife and

Environmental Law Enforcement (DFWELE), WOLCS, and the Nimrod League of Holden. It is an important corridor between the Savage Hill and Wekepeke Brook focus areas and is the nearest large area of limited development to the west of Wachusett Reservoir. Poutwater Pond and the adjacent, large Spruce-Tamarack Bog are MNHESP Priority Habitat and the wetland / upland combination on the east side of Flagg Hill and west of Mason Road are likely important reptile and amphibian breeding habitat. One third of the focus area is identified as having permanent or limited protection.

High Ridge WMA (3,954 acres)

This focus area is centered on High Ridge WMA which includes extensive open meadows managed for hay. Bobolinks were present during a July field visit, however repeated mowing throughout the summer may deter nesting by more disturbance-sensitive grassland nesting birds. Wetlands within this area provide habitat for state-endangered American bitterns, a strong indicator of low human disturbance. Together with the Lake Womponoag focus area, these open lands of the Worcester Plateau provide undisturbed habitat for large mammals ranging south from the Mt. Watatic area. DFWELE staff report moose and bear activity in the area.

Over half (54%) of the area is permanently protected as the WMA and Westminster State Forest.

Horse Hill/Baddacook Pond (3,809 acres)

This area on the watershed boundary in Groton and Dunstable includes almost 500 acres of the Wharton Plantation owned by the New England Forestry Foundation. Other conservation owners include the Town of Groton Conservation Commission and Water Department, as well as the Groton Conservation Trust. Together those organizations and departments hold 33% of the land in some form of protection, though only 7% is listed by MassGIS as permanently protected. MNHESP recognizes four Priority Habitats within or intersecting this focus area: one along the Unkety Brook at the north end, one along the power line right-of-way east of Kemp Street, and two others located on the north and east sides of Chestnut Hills.

Willard Brook State Forest (3,732 acres)

This large area in Ashby, Townsend, and Lunenburg is over 60% permanently protected as DEM's Willard Brook State Forest. Important conservation opportunities include Rattlesnake / Fort Hill which is largely unprotected and several Chapter 61 properties at the southern end of the area which are important for maintaining continuity between the core of Willard Brook SF and the Pearl Hill Brook area to the south.

Whitney Hill/ Muddy Pond (3,665 acres)

Straddling the Ashburham-Westminster town line, this area contains a prominent north-south ridge that connects large open areas to the north and south. Small roads dissect the area, and some land is used for agriculture. This area may not be one of the habitat cores of an overall reserve design, but is a crucial stepping stone between others in the constellation of open areas found in the northwestern corner of the watershed. Only 1% of the area is permanently protected, by DEM as part of Westminster State Forest. Forested wetlands to the west of Willard and Bragg Hill Roads could include vernal pools.

Mt. Hunger/Russell Hill (1,896 acres)

This section of Ashburnham is another focus area to be considered more for its value as a habitat connector than a large, undisturbed core. The area contains two ridges leading off of the Worcester Plateau including uncommonly steep terrain on the east side of Mt. Hunger. None of the land is listed as protected open space by MassGIS.

Wright Ponds (3,589 acres)

The focus area centered on Wright Ponds in Ashby, together with the Falulah Brook focus area in Fitchburg, connects Willard Brook State Forest to the large open areas of the Worcester Plateau on the watershed's western boundary. The steep, cool streams are feeders of the Squannacook, and the wet meadows below Lower Wright Pond are high quality habitat. A ridge running through the southwestern quadrant of this area could be part of a wildlife corridor toward Mt. Watatic. Only 18% of this area is protected, some as part of Willard Brook SF.

Small Focus Areas and Riparian Corridors

There were 19 small focus areas that include another 10% of the watershed. In addition, 4 riparian corridors were identified. These small areas will continue to provide habitat for smaller animals. As long as they maintain some connections to larger areas of natural habitat, they can also act as stepping stones for larger animals moving from large focal area to other large areas. The descriptions of the focus areas below were taken directly from the Mass Audubon focus area report.

Hound Meadow Hill/Hawk Swamp (3,100 acres)

Though crossed by small roads and including farmland and two gravel pits, this lightly developed northwestern corner of Dunstable is important for its 2.5 miles of undeveloped riverbank along the Nashua River and its role as buffer for Unkety Brook , associated wetlands and adjacent wooded uplands. Hollis Street in Dunstable runs along the ridge dividing this area into a western and eastern half, and separating the Nashua and Merrimack watersheds. The Nashua River at this point is a Priority Habitat with five listed species associated with it. Hawk Swamp, a Spruce-Fir Boreal Swamp, is an example of a natural community type near the southern end of its range. Unkety Brook has been identified as exceptional habitat for aquatic wildlife. Eight percent of this focus area is listed as permanently protected land, with another 13% with limited protection.

Squannacook Hill/Groton Town Forest (2,820 acres)

Featuring the confluence of the Squannacook and Nashua Rivers, this focus area is important for its floodplain forest habitat, extensive wetlands with adjacent uplands, and as a buffer to the riparian corridor along the Squannacook and Nashua Rivers, and Mulpus Brook. Development along Longley, Lawton, and Kittredge Roads limits the area of interior forest habitat here, and precludes this parcel from acting as a habitat core, but it is well-located as a stepping stone for wildlife movement north from the Oxbow NWR.

Between the Squannacook River WMA and the Ayer State Game Farm, 8% of the area is protected permanently; another 21% is under limited protection as the Groton Town Forest, and 7% is owned by the Shirley Rod & Gun Club.

Upper Naukeag/Lincoln Pond (2,686 acres)

Another site on the border of the watershed in Ashburnham, this medium sized core is an important stepping stone between the large Mt. Watatic and Lake Wompanoag sites. Upper Naukeag Lake (outside the watershed) is listed as MNHESP Priority Habitat, and beside Lincoln Pond is another fine example of a Spruce-Tamarack Bog approximately 40 acres in size.

DEM owns or holds conservation restriction over 50% of this site.

Snake Hill/Long Pond (2,471 acres)

Straddling the Ayer-Groton border, this area contains a diverse combination of uplands adjacent to extensive wetlands. Powerline and gas rights-of-way provide corridors and the network of swamps and marshy areas are likely important undisturbed breeding habitat for multiple species. The network also provides dispersal routes between the large ponds in the area – Flannagan and Sandy Ponds to the southwest, Spectacle Pond to the southeast, and Knops Pond and Lost Lake to the northeast. Very little of the area is protected land – the Groton Conservation Commission owns a small parcel at Half Moon Swamp, and 8% is in limited protection, partly as the Rod & Gun Club.

Townsend Hill (2,300 acres)

This almost entirely unprotected, yet undeveloped area in northeast Townsend is important as a connector between Townsend State Forest to the west, Gulf Brook to the east, and the Nissitissit River to the north. Gulf Brook has potential habitat for black bear and bobcat, and the prominent ridge of Townsend Hill, with its steep eastern shoulder, is likely utilized as well by both species. A cluster of vernal pools has been certified along Wheeler Street to the east of Townsend Hill, and that area is listed as Priority Habitat. Some of the numerous small water bodies on Townsend Hill itself are probably vernal pools; the area should be investigated in the Spring for vernal pool fauna.

McGovern Brook (2,283 acres)

The McGovern Brook focus area, including White Pond and a stretch of the North Nashua River, is high quality habitat in its own right, but is of utmost importance as a buffer between downtown Leominster and the Oxbow / Intervale / Bolton Flats focus area. The combination of wetlands and gravel pits could provide ideal habitat for turtles looking for sandy deposits for their eggs. Abandoned or partially active gravel pits can be well managed as habitat for bank nesting birds as well. The north bank of the North Nashua includes low lying land that could develop as flood plain forest, an uncommon natural community type in the watershed. Twenty percent of the area is already permanently protected as Chapman-Goodale, Chickering, and Cook Conservation Areas, and Lancaster State Forest.

Ballard Hill (2,244 acres)

Like McGovern Brook, Ballard Hill in Lancaster and Sterling is important as a buffer for Oxbow / Intervale / Bolton Flats, yet the west side of Ballard Hill and the section south of Flanagan Hill Road contain numerous certified vernal pools, and the vicinity of unnamed stream draining north, crossing at the intersection of Flanagan Hill, Hilltop, and Brockelman Roads, is a MNHESP Priority Habitat area. Lancaster Town Forest and New England Forestry Foundation lands protect 17% of the area permanently.

Falulah Brook (2,224 acres)

A narrow focus area without abundant interior habitat, this site in Ashby and Fitchburg is nonetheless important buffer for Falulah Brook and Fitchburg Reservoir, and a connector in the chain of habitat stretching from Lake Wompanoag to Townsend State Forest and beyond. Fitchburg Reservoir is important bird habitat and a Heritage Priority Habitat site. Between Audubon and other owners, 49% of the land is protected.

The Throne (1,916 acres)

The Throne, located in Groton and Pepperell, is special for the extent of undeveloped upland in West Groton, and the number of vernal pools it harbors on its upper slopes. The Throne itself has been identified as a conservation priority by the Nashua River Watershed Association and the Town of Groton. Groton Conservation Commission, Groton Conservation Trust, and New England Forestry Foundation own 19% of the land. The

Throne is a central part of the set of focus areas that provide functional habitat in the northeastern corner of the watershed. It is an important link between the Squannacook River corridor and the J. Harry Rich State Forest and Squannacook Hill focus areas.

Hunting Hills/Mulpus Brook (1,876 acres)

This area is 43% permanently protected as Hunting Hills WMA and the Cowdrey Nature CenterFour large Chapter 61 properties add another 13% of the area in temporary protection. This area is an important connector between Witch Brook to the northwest and Mulpus Brook to the southeast. Mulpus Brook in turn leads to the Squannacook Hill focus area and the Nashua mainstem. These are crucial stepping stones for wildlife movement towards the large Oxbow / Intervale / Bolton Flats core area. The marsh just below the outlet from Hickory Hills Lake, is a MNHESP Priority Habitat, as is the wetland at the north end of the focus area.

Gulf Brook (1,849 acres)

Gulf Brook is one of the small treasures of the watershed. Though this focus area is long and narrow, without tremendous amounts of interior, its geology and location at the southern end of the expansive Birch Hill / Rocky Pond focus area makes it truly unique in the watershed, and topography creates a more isolated environment than the focus area outlines would suggest. The Heald Pond section, and the gorge to the north of the pond are potential habitat for black bear and bobcat, and endangered invertebrates. Other uncommon species, such as various bats make use of the blocky bedrock outcropping in the gorge. The gorge and the Gulf Brook are natural corridors for wildlife movement south from New Hampshire. More than half of the land enjoys some level of protection, with Belmont Springs Bottling Company and the Town of Pepperell being the largest landowners.

Bixby Reservoir (1,609 acres)

This focus area is important for its location as a connector between Pearl Hill Brook and Willard Brook SF focus areas, and Bixby Brook and the Lower Squannacook River. This set of focus areas in the north-central section of the watershed provide an east-west link from the Worcester Plateau highlands and the large focus areas of Lake Wompanoag and Mt. Watatic to the Nashua mainstem lowlands in Shirley and Groton. About 18% of the area is permanently protected as Lunenburg Town Forest and another 14% is in Chapter 61b.

This medium sized area has been split in two by residential development along Tyler Road, however the density of house lots may be sufficiently low that ecological contiguity is maintained.

Unionville Pond/Quinapoxet River (1,531 acres)

Consisting of a large amount of MDC-owned land in Holden, this focus area is important as a connector between the Savage Hill focus area and the Stillwater River well as a buffer between the Poutwater Pond focus area and the center of Holden. The Quinapoxet and its tributaries here are identified by MNHESP as Priority Habitat. More than half of the land is currently protected; however, the hill north of River Street appears to be unprotected, and any development here would divide a degrade the value of this focus area as a stepping stone and buffer.

J Harry Rich State Forest/Shephard Hill (1,524 acres)

The Nashua River as it passes through this focus area has been identified by Nashua River Watershed Association aquatic experts as important habitat for birds, fish, and turtles. The slow, meandering nature of the river here, with many oxbows and backwaters offers a rich combination of warm, sluggish water, a few marshy areas, and wide, sandy lowlands that provide shelter, feeding, and breeding habitat for a variety of wildlife. The state forest is the centerpiece of this focus area, with 41% of the land permanently protected.

Pearl Hill Brook (1,303 acres)

This area is an important buffer between Willard Brook State Forest and the urban development of Fitchburg. The eastern quarter drains into Mulpus Brook and provides upland adjacent to the brook that may function as a corridor to the Bixby Reservoir focus area. The area straddles a ridge that runs north into the Willard Brook SF which may be another important wildlife corridor

Parker Hill (1,169 acres)

Parker Hill is the southern terminus of a ridge running south from Mt. Hunger in Ashburnham. Though a small focus area, it contains the lower section of MNHESP Priority Habitat centered on Phillips Brook, and provides important buffer to the dense development of West Fitchburg. Only 5% of the area is protected in any way.

Bixby Brook (1,163 acres)

This focus area is another important connector between the Squannacook River and large open areas to the west. DEM owns 33% of the area, permanently protected as part of Townsend State Forest. Another 22% is owned by the Townsend Rod & Gun Club. The state forest section includes a large riverside marsh and meanders of the Squannacook. The northeast section of this marsh is unprotected

Trapfall Brook (1,102 acres)

This small area is another stepping stone for animals ranging south into Ashby and east-west from Mt. Watatic to Townsend State Forest. The ~50 acre wetland on Trapfall Brook, south of the Mason Road-Foster Road intersection is a MNHESP Priority Habitat and likely provides habitat for a large number of reptiles, amphibians, birds, and invertebrates.

Long Swamp/Catacoonamug Brook (837 acres)

An intricate network of eskers in Long Swamp as well as the extent of wetlandin Long Swamp and along Catacoonamug Brook make this focus area a standout. The wetlands are likely turtle habitat and eskers are often associated with uncommon plant communities. Fifteen percent of the area is permanently protected under municipal ownership, and another 25% is in Chapter 61. The priorities here are protection of Long Swamp and maintenance of the southern end of the focus area in conservation land.

Riparian Corridors

The four riparian corridors identified are important not only as aquatic and riparian habitat, but also as corridors between the larger natural areas.

Squannacook River

The Squannacook River is listed by several people familiar with the watershed as a central component of wildlife habitat quality. Its headwaters drain an area that is some of the most forested, least developed in the watershed, leaving the Squannacook a cold, clean river that is frequently cited as prime habitat for native brook trout, and state listed species of dragonflies, mussels, reptiles, and amphibians. The boundaries of the Upper and Lower Squannacook River focus areas directly correspond to MNHESP Priority Habitat areas.

Much of the Lower Squannacook focus area (29%) is protected by the Squannacook River WMA. The Townsend Rod & Gun Club property makes up another 4% of the area as land in limited protection.

A small proportion of the Upper Squannacook River focus area (7%) is protected by the Squannacook River WMA and Townsend State Forest.

Nashua River/Mulpus Brook

This stretch of the Nashua mainstem is perhaps the most important corridor in the watershed. Its main function is to connect the expanse of high quality habitat in the Oxbow focus area with the smaller areas to the north that are stepping stones to the large open space of north Lunenburg and Townsend. The bridge carrying Route 2 over the Nashua River is one of the few locations for wildlife to cross the barrier created by the highway. A second, possibly more important passage is by the railroad underpass just east of the Nashua River bridge, at the northeast corner of the Oxbow / Intervale / Bolton Flats focus area. The area south of Sheridan Road on the Devens North Post, and the uplands adjacent to the Nashua near the Devens exits from Route 2 should be carefully managed for wildlife movement to and from the Oxbow focus area.

The uplands adjacent to the Nashua at the southern end of this corridor include an ash swamp, floodplain forest, and a mesic terrace, all uncommon natural communities. Catacoonamug Brook offers a riparian corridor toward the Long Swamp / Spruce Swamp focus area, though it does pass through the center of Shirley; it is certainly valuable as aquatic habitat. Further north the Nashua River corridor widens to include marshy wetlands on low ground adjacent to the river, then connects to the Squannacook Hill focus area. Moore Airfield may offer habitat for grassland nesting birds and small prey species, and the wide, low area southwest of the airfield is a Heritage Priority Habitat for four listed species. The Mulpus Brook corridor extends northwest, through the southern section of the Squannacook Hill focus area, to the Hunting Hills focus area. Twenty-two percent of the corridor is protected.

Stillwater River Corridor

The boundaries of this corridor correspond directly to the MNHESP Priority Habitat area which extends to include all of Wachusett Reservoir, and is identified as habitat for ten listed species. The corridor connects Wachusett Reservoir with Unionville Pond focus area which is a stepping stone to the large Poutwater Pond and Savage Hill / Quinapoxet Reservoir focus areas, and the Wekepeke River focus area which leads to Leominster State Forest. As the river corridor that stretches between three of the largest focus areas in the watershed, and as fine aquatic habitat with important floodplain forests adjacent, the Stillwater River is another area crucial for protection of landscape level processes. Fortunately, nearly the entire area is already protected, primarily by the MDC.

Nissitissit River

The Nissitissit, like the Squannacook River, is identified by aquatic biologists, anglers, entomologists, and land protection professionals as one of the highest quality stretches of aquatic habitat in the watershed. As a wildlife corridor, it connects the Hound Meadow Hill / Hawk Swamp focus area with Gulf Brook and the large focus areas of Townsend and southern New Hampshire, as well as the large protected lands along Beaver Brook. Largely because the tributary streams in Brookline and Mason flow through the undeveloped land identified as Badger Hill / Spaulding Brook and Townsend State Forest focus areas, the Nissitissit is a clean, cold, well-oxygenated stream important to invertebrates and native trout. The entire length of the Nissitissit in Massachusetts is identified as Natural Heritage Priority Habitat for five listed species. Thirteen percent of the corridor area is permanently protected as the Nissitissit River WMA. Protection priorities include the upper area of the corridor between Brookline center and South Brookline, and the lowlands adjacent to the river between North Pepperell and Four Corners.

Appendix IV – References

Some of the references fall in multiple categories and will appear more than once below.

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Walton, R.K. and R.W. Lawson. 1991. Peterson field guides: Backyard bird song, Houghton Mifflin Co. (1 Audio CD, 66 minutes, 28 species).

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Yates, S. 1989. Adopting a wetland: A northwest guide. Snohomish County Planning and Community Development. To obtain, contact: The Adopt-A-Stream Foundation, Northwest Stream Center, 600-128th St, SE, Everett, WA 98208-6353; (425) 316 8592; www.streamkeeper.org.

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US Environmental Protection Agency, Office of Wetlands, Oceans, and Watersheds, Wetlands Division. 1996. Indicators for monitoring and assessing biological integrity of inland, freshwater wetlands: A survey of technical literature (1989 – 1996). EPA ID # 843-R-98-002.

US Environmental Protection Agency, Office of Wetlands, Oceans, and Watersheds. 1998. National Directory of Volunteer Environmental Monitoring Programs. EPA ID # 841-B-98-009; http://yosemite.epa.gov/water/volmon.nsf.

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Hellquist, C. Barre. 1998. A guide to invasive non-native aquatic plants in Massachusetts. Massachusetts Department of Environmental Management, Lakes and Ponds Program. 100 Cambridge St, Boston, MA 02202. (617) 727-3267 x 524.

Jackson, S. March, 1995. Delineating bordering vegetated wetlands under the Massachusetts Wetlands Protection Act. Massachusetts Department of Environmental Protection, Division of Wetlands and Waterways.

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Appendix V - Resources – Agencies and Organizations

Watershed Associations

There are 27 watershed groups in Massachusetts. Visit the Massachusetts Watershed Initiative page (http://www.state.ma.us/envir/mwi/watersheds.htm) and there are links to each of these watershed groups. We listed the contact information for the Nashua River Watershed Association below.

Nashua River Watershed Association

592 Main St
Groton, MA 01450
Tel. (978) 448 0299
Fax. (978) 448 0941
Web. www.nashuariverwatershed.org

Regional planning commissions

Montachusett Regional Planning Commission

R1427 Water St
Fitchburg, MA 01420
Tel. (978) 345 7376
Fax. (978) 345 9867
Web. www.mrpc.org
Majority of Nashua River watershed towns are located within MRPC's jurisdiction

Central Massachusetts Regional Planning Commission

35 Harvard St
Worcester, MA 01609
Tel. (508) 756 7717
Fax. (508) 792 6818
Email. cmrpc@cmrpc.org
Web. www.cmrpc.org
West Boylston, Boylston, Rutland, Princeton, Holden, Paxton

Northern Middlesex Council of Governments

Gallagher Terminal, Floor 3B
115 Thorndike St
Lowell, MA 01852-3308
Tel. (978) 454 8021
Fax. (978) 454 8023
Email. mail@nmcog.org
Web. www.nmcog.org
Pepperel, Dunstable

Southwest Regional Planning Commission

20 Central Sq, 2nd Floor
Keene, NH 03431
Tel. (603) 357 0557
Fax. (603) 357 7440
Email. admin@swrpc.org
Web. www.swrpc.org
Mason, Greenville

Nashua Regional Planning Commission

115 Main St
PO Box 847
Nashua, NH 03061
Tel. (603) 883 0366
Web. www.nashuarpc.org
Brookline, Hollis, Nashua

Rockingham Planning Commission

156 Water St
Exeter, NH 03833-2487
Tel. (603) 778 0885
Fax. (603) 778 9183
Web. www.nh.ultranet.com/~rpc

Southwest Regional Planning Commission

20 Central Sq, 2nd floor
Keene, NH 03431-3771
Tel. (603) 357 0557
Fax. (603) 357 7440
Web. www.swrpc.org

Conservation commissions

Massachusetts Association of Conservation Commissions (MACC)

10 Juniper Rd
Belmont, MA 02478
Tel. (617) 489 3930
Fax. (617) 489 3935
Web. www.maccweb.org/home.html

New Hampshire Association of Conservation Commissions

54 Portsmouth St.
Concord, NH 03301
Tel. (603) 224 7867
Web. www.nhacc.org/nhacc.htm

Contact the town offices in any of the Nashua River Watershed towns listed below:

Ashby, MA
Ayer, MA

Boylston, MA
Dunstable, MA
Fitchburg, MA
Groton, MA
Harvard, MA
Holden, MA
Lancaster, MA
Lunenburg, MA
Pepperel, MA
Princeton, MA
Shirley, MA
Sterling, MA
Townsend, MA
West Boylston, MA
Westminster, MA
Mason, NH
Brookline, NH
Hollis, NH
Nashua, NH

State offices

MassGIS (Massachusetts Geographic Information System)

251 Causeway St
Boston, MA 02114
Tel. (617) 626 1000
Fax. (617) 626 1249
Web. http://www.state.ma.us/mgis/

GRANIT

GRANIT Project
Complex Systems Research Center
Morse Hall
University of New Hampshire
Durham, NH 03824
Tel. (603) 862 1792
Email. Granit@unh.edu
Web. http://www.granit.sr.unh.edu/

Massachusetts Executive Office of Environmental Affairs

251 Causeway St, 9th floor
Boston, MA 02114
Tel. (617) 626 1000
Fax. (617) 626 1181
Web. http://www.state.ma.us/envir/eoea.htm

New Hampshire Department of Environmental Services

6 Hazen Dr

Concord, NH 03301
Tel. Biology Bureau (603) 271 3414
Tel. Drinking Water Maps (603) 271 1168
Tel. Favorable Gravel Well Maps (603) 271 7061
Tel. Rivers Protection and Management Program (603) 271 1152
Tel. Water Well Board (State geologist's office) (603) 271 3503
Tel. Wetlands Bureau (603) 271 2147
Web. www.des.state.nh.us

Massachusetts Wetlands Restoration Program

Executive Office of Environmental Affairs
One Winter St – 5th Floor
Boston, MA 02108
Tel. (617) 626 1177
Fax. (617) 292 5850
Email wetlands.restoration@state.ma.us
Web. www.state.ma.us/envir/mwrp/index.htm

GROWetlands (Groups Restoring Our Wetlands)

This program is implemented by the Massachusetts Wetland Restoration Program. Visit the GROWetlands website for more information.

Web. www.state.ma.us/envir/mwrp/growetlands.htm

Massachusetts Watershed Initiative

Nashua River Watershed Team Leader
Jo Anne Carr
180 Beaman St
West Boylston, MA 01583
Tel. (508) 835 4816 ext. 501
Fax. (508) 835 6018
Email. Joanne.carr@state.ma.us
Web. http://www.state.ma.us/envir/mwi/watersheds.htm

Massachusetts Department of Environmental Management

251 Causeway St, Suite 600
Boston, MA 02114-2104
Tel. (617) 626 1250
Fax. (617) 626 1349
Email. Mass.Parks@State.MA.US
Web. http://www.state.ma.us/dem/index.htm

Programs within the Massachusetts Department of Environmental Management

Massachusetts Forest Stewardship Program
433 West Street
Amherst, MA 01002
Website: http://www.state.ma.us/dem/programs/forestry/service/steward.htm

Department of Environmental Management, Division of Forests & Parks Regional Offices

Region II: Essex, Middlesex, Norfolk counties

817 Lowell Road, PO Box 829
Carlisle, MA 01741
Tel. (978) 369 3351

Region III: Worcester county

Route 110, Box 155
Clinton, MA 01510
Tel. (978) 368 0126

Massachusetts Department of Environmental Protection

Central Regional Office
627 Main St
Worcester, MA 01608
Tel. (508) 792 7650
Fax. (508) 792 7621
Email. jbusick@state.ma.us
Web. Central Regional Office http://www.state.ma.us/dep/cero/cerohome.htm
Web. Main Office http://www.state.ma.us/dep/dephome.htm

Massachusetts Historical Commission

220 Morrissey Boulevard
Boston, MA 02125-3314
Tel (617) 727 8470

New Hampshire Division of Historical Resources

19 Pillsbury St
Box 2043
Concord, NH 03301-2043
Tel. (603) 271 2462
Web. www.state.nh.us/nhdhr

Wildlife Related Resources

Natural Heritage and Endangered Species Program

Massachusetts Division of Fisheries and Wildlife
North Drive
Westborough, MA 01581
Tel. (508) 792 7270
Fax. (508) 792 7821
Email. Natural.heritage@state.ma.us
Web. http://www.state.ma.us/dfwele/dfw/nhesp/heritage.htm

New Hampshire Natural Heritage Inventory (NHNHI)

PO Box 1856

172 Pembroke Rd
Concord, NH 03302-1856
Phone: (603) 271 3623
Fax: (603) 271 2629
Email: sarac@dred.state.nh.us
Website: www.nhdfl.com/formgt/nhiweb/

New Hampshire Audubon offices

Becky Suomala
Audubon Society of New Hampshire
Three Silk Farm Road
Concord, NH 03301
603-224-9909 ext. 309
birdsetc@nhaudubon.org
(shared acct - "Attn. Becky"
send hardcopy or call to verify)

Mass Audubon Breeding Bird Survey, Massachusetts

Wayne Petersen
Massachusetts Audubon Society
208 South Great Road
Lincoln, MA 01773
Tel. 781-259-9500
Email. wpetersen@massaudubon.org
Web. http://www.mp2-pwrc.usgs.gov/bbs/

New Hampshire Breeding Bird Survey, Contact

Becky Suomala
Audubon Society of New Hampshire
3 Silk Farm Rd
Concord, NH 03301
Tel. (603) 224 9909 x 309
Email. birdsetc@nhaudubon.org (shared account, please write "attn Becky" in the subject line)
Web. http://www.mp2-pwrc.usgs.gov/bbs/

Massachusetts Division of Fisheries and Wildlife

Central Wildlife District
Temple St
West Boylston, MA 01583
Tel. (508) 835 3607
Fax. (508) 792 7420
Email. Chris.Thurlow@state.ma.us (Central District Wildlife Manager)
Web. http://www.state.ma.us/dfwele/dpt_toc.htm

New Hampshire Fish and Game Department

2 Hazen Dr
Concord, NH 03301
Tel. (603) 271 2462

Web. www.wildlife.state.nh.us

Invasive Plant Atlas of New England

Les Mehroff
George Safford Torrey Herbarium
Department of Ecology and Evolutionary Biology
University of Connecticut
Tel. (860) 486 1889
Email. vasculum@uconnvm.uconn.edu
Web. http://invasives.eeb.uconn.edu/ipane/

Educational Institutions

Universities and University Extension

University of Massachusetts Extension Natural Resources and Environmental Conservation Program

Scott D. Jackson, Program Director
Department of Natural Resources Conservation
Holdsworth Natural Resource Center
University of Massachusetts
Amherst, MA 01003
Tel. (413) 545-4743
Fax. (413) 545-4358
Email. sjackson@umext.umass.edu

University of New Hampshire Cooperative Extension Offices

Hillsborough County Office

468 Route 13 South
Milford, NH 03055
Tel. (603) 673 2510
Fax. (603) 672 1727

Rockingham County Office

113 North Rd
Brentwood, NH 03833
Tel. (603) 679 5616
Fax. (603) 679 8070

University of Massachusetts Extension Service

Scott D. Jackson
Department of Natural Resources Conservation
Holdsworth Natural Resource Center
University of Massachusetts
Amherst, MA 01003
(413) 545-4743 (voice)
(413) 545-4358 (fax)Email: sjackson@umext.umass.edu

UMass Department of Environmental Sciences

312 Stockbridge Hall
University of Massachusetts
80 Campus Center Way
Amherst, MA 01003-9246
Dr. Guy R. Lanza, Director
Phone: (413) 545 3747
Email: glanza@fnr.umass.edu
Website: www.umass.edu/envsci/

UMass Department of Landscape Architecture and Regional Planning

109 Hills North
University of Massachusetts
Amherst, MA 01003
Phone: (413) 545 2255
Fax: (413) 545 1772
Email: skoczur@larp.umass.edu
Website: www.umass.edu/larp/

UMass Citizen Planner Training Collaborative

(Jointly supported by UMass Extension and the Department of Landscape Architecture and Regional Planning)

302 Hills North
University of Massachusetts
Amherst, MA 01003
Email: masscptc@umext.umass.edu
Website: www.umass.edu/masscptc/

UMass Department of Natural Resources Conservation

Holdsworth Natural Resources Center
University of Massachusetts
Amherst, MA 01003-9285
Phone: (413) 545 2665
Fax: (413) 545 4358
Email: bmccomb@forwild.umass.edu (William C. McComb, Head)
Website: www.umass.edu/forwild/

UMass Office of Geographic Information and Analysis

105 Hasbrouck Lab
University of Massachusetts
Amherst, MA 01003
Tel: (413) 545 2842 (Dr. Richard Taupier, Director)
Email: taupier@tei.umass.edu (Dr. Richard Taupier, Director)
Website: www.umass.edu/tei/ogia/index.html
The Office of Geographic Information and Analysis (OGIA) was established in July 1994 to assist the academic community of the University of Massachusetts in its efforts to use GIS technologies in teaching, research, and public service. OGIA contracts with regional

planning agencies, municipalities, and state government, as well as with companies in the private sector for GIS projects to be carried out by our graduate student staff.

Conway School of Landscape Design

PO Box 179
Conway, MA 01341-0179
Phone: (413) 369 4044
Email: conway@csld.edu
Website: www.csld.edu

The Center for Environmental Education of Antioch New England Institute

40 Avon St
Keene, NH 03431-3516
Phone: (603) 355 3251
Email: cee@antiochne.edu
Website: www.schoolsgogreen.org/

Natural Resource Conservation Service (NRCS) and Conservation District Offices

Hillsborough County Conservation District and NRCS

Chappell Professional Center
#468, Route 13 South
Milford, NH 03055-3442
Tel. (603) 673 2409
Fax. (603) 673 0597

Rockingham County Conservation District Office

118 North Rd
Brentwood, NH 03833-6614
Tel. (603) 679 2790
Fax. (603) 679 2860

Rockingham County NRCS

243 Calef Highway
Telly's Plaza
Epping, NH 03042
Tel. (603) 679 1587
Fax. (603) 679 4658

Holden, MA NRCS Field Office

The Medical Arts Center Building
52 Boyden Rd, Room 10
Holden, MA 01520-2587
Tel. (508) 829 4477 ext 3
Fax. (508) 829 3721
Web. http://www.ma.nrcs.usda.gov/

Worcester, MA Conservation District Office

The Medical Arts Center Building
52 Boyden Rd, Room 100
Holden, MA 01520-2587
Tel. (508) 829 4477 ext 5
Fax. (508) 829 3721

Farm Service Agencies

Hillsborough County FSA Office

Chappell Professional Building
468 State Route 13 South
Milford, NH 03055
Tel. (603) 673 1222
Fax. (603) 673 0597

Rockingham-Strafford County FSA Office

243 Calef Highway, Route 125
Epping, NH 03042-2326
Tel. (603) 679 4656
Fax. (603) 679 4658

Worcester County FSA Office

Holden Service Center
52 Boyden Rd
Holden, MA 01520-2592
Tel. (508) 829 4477
Fax. (508) 829 3721

Federal offices

National Fish and Wildlife Service

New England Field Office
70 Commercial St, Ste 300
Concord, NH 03301-5087
Tel. (603) 223 2541
Fax. (603) 223 0104
Email. FW5ES_NEFO@fws.gov
Web. http://northeast.fws.gov/index.html

US Geological Survey Massachusetts Office

Wayne H. Sonntag
10 Bearfoot Road
Northborough, MA 01532
Tel. (508) 490-5000
Fax. (508) 490-5068
Email. dc_ma@usgs.gov
Web. http://interactive2.usgs.gov/contact_us/index.asp?state=MA

Environmental Protection Agency

Wetland Resources
EPA Wetland Helpline: 1800 832 7828, wetlands.helpline@epa.gov
EPA wetland web site: www.epa.gov/owow/wetlands
EPA restoration web site: www.epa.gov/owow/wetlands/restore
EPA volunteer monitoring web site: www.epa.gov/owow/monitoring/vol.html
The spring 1998 issue of The Volunteer Monitor newsletter focusing on wetland monitoring is available on the EPA web site at www.epa.gov/owow/volunteer/vm_index.html.

Breeding bird survey

Breeding Bird Survey - U.S. Department of the Interior (http://www.doi.gov/) | U.S. Geological Survey (http://www.usgs.gov/)
Patuxent Wildlife Research Center Laurel, MD, USA 20708-4038
http://www.pwrc.usgs.gov/bbs
Operations Contact: Keith Pardieck, email: Keith_Pardieck@usgs.gov
Analyses Contact: John Sauer, email: John_Sauer@usgs.gov

U.S. Department of the Interior

U.S Fish and Wildlife Service
Division of Habitat Conservation
1849 C. Street, NW, Room 400
Arlington Square, Washington, D.C. 20240
Phone: (703) 358 2201

Invasive Plant Atlas of New England (IPANE)

Bryan Connolly
Invasive Plant Survey Coordinator
76 Warrenville Rd
Mansfield Center, CT 06250
Phone: (860) 423 8305
Phone(2): (508) 877 7630 ext. 3208
Email: bconnolly@newfs.org or connollybryan@hotmail.com

Other useful organizations

North East Hawk Watch

Massachusetts contact – Paul Roberts
254 Arlington Street
Medford, MA 02155
Email. proberts@analogic.com
Web. http://www.battaly.com/nehw/
New Hampshire contact – Susan Fogleman
RR# 1 Box 2011
Plymouth, NH 03264
Email. fogleman@cyberportal.net

Paul Rezendes Photography and Nature Programs

3833 Bearsden Rd.
Royalston, MA 01368-9400
Phone: (978) 249 8810
Fax: (978) 249 3907
e-mail: programs@paulrezendes.com
Website: www.paulrezendes.com

New England Naturalist Training Center

299 Birnam Rd
Northfield, MA 01360-1149
Phone: (413) 498 2584
Email: foster@nentc.com
Website: www.nentc.com

Clean Water Fund

36 Bromfield St. # 204
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Appendix VI – GLOSSARY

Definitions labeled with a * were obtained from the Funk and Wagnalls Standard College Dictionary, Harcourt, Brace, and World, Inc. New York, NY. 1966.

Bedrock geology * - the solid rock that underlies loose material, such as soil, sand, clay, or gravel.

Biomass - above-ground weight of the plants of a species

Catchment area – a relatively small area that drains to a single stream or small water course

Cover - area covered by the above-ground parts of a species when viewed from directly above

Data layers – A Geographic Information System (GIS) makes use of many different "data layers" of information such as streams, roads, water bodies, property parcels, and town boundaries. Each layer of information can be laid on top of other data layers so that relationships between the various layers can quickly and easily be seen.

DEM – Digital Elevation Model

Density - individuals in a unit area

Endangered – endangered species are native species which are in danger of extinction throughout all or part of their range, or which are in danger of extirpation from Massachusetts, as documented by biological research and inventory.

Flagship – charismatic animals, like wolves and eagles, which build popular support for the protected area.

Focal species – Even with unlimited time to study an ecosystem, it would still be impossible to know all the needs of every species and all of the myriad interactions between species. As a substitute for designing reserves with hundreds of species in mind, ecologists use a small number of representative species to plan for the protection of many species. By managing for the protection of these focal species, a successful reserve design will maintain ecosystem conditions upon which many other species rely, thus contributing to their protection (Miller et al 1999; Lambeck 1997). Generally, there are six types of focal species as described by Foreman et al. (2000):

Frame quadrat – quadrats are used to define sample areas within the study area. They can be made from a variety of materials and are usually square or rectangular in shape. Other shapes can be used, as long as the exact area contained within the shape is known.

Frequency - number of samples in which a species is found

GPS – Abbreviation for Global Positioning System – A satellite-based global navigation system that consists of a) a constellation of 24 satellites in orbit 11,000 nautical miles above the Earth, b) several on-station (i.e. in-orbit) spares, and c) a ground-based control segment. The satellites transmit signals that are used for extremely accurate three-dimensional (latitude, longitude, and elevation) global navigation, and for the dissemination of precise time. GPS-derived position determination is based on the arrival times, at an appropriate receiver, of precisely timed signals from the satellites that are above the user's radio horizon. (Definition from www.atis.org/tg2k/_gps.html)

Habitat quality indicator – species that require natural habitat of high ecological integrity and that provide an early warning system because they are sensitive to ecological changes.

Igneous – Formed by the action of great heat within the earth, as rocks consolidated from a molten state. *

Keystone – species that enrich ecosystem function in a unique and significant manner through their activities, and the effect is disproportionate to their numerical abundance. The extirpation of keystone species often triggers other extirpations and significant changes or loss of habitats. Large carnivores are often keystone species. The beaver, through its modification of the landscape is another keystone species (Mills et al 1993)

pH – A symbol denoting the negative logarithm of the hydrogen ion concentration, in grams per liter, of a solution: used in expressing relative acidity and alkalinity. *

QAPP – Quality Assurance Project Plan - a document that outlines the methods that your monitoring project will use in order to collect samples, record data, and report data and important findings. If the monitoring project is implemented primarily with the help of volunteers, the QAPP is very important to add credibility to the project and to keep the monitoring efforts consistent.

Representation – In an ideal reserve design, all native natural communities would be represented within protected areas; but realistically, one must decide which communities are more important for the protection of biodiversity, and then how many examples of each community to include in a conservation network. In Guidelines for Representing Ecological Communities in Ecoregional Conservation Plans, The Nature Conservancy presents a framework for considering these questions and developing answers. They recommend setting conservation targets by considering Heritage Program information on the rarity and diversity of natural communities with expert input by those familiar with the study area. For deciding how much of a given community type is enough to protect, they consider three factors. First is the geographic scale and spatial pattern of the community in the conservation planning unit -- is it a matrix community, such as white pine-oak in the Nashua that needs protection over wide areas, or is the target red maple swamps that are local in extent. Second, the proportion of the community's total distribution contained within the planning unit – is the community common all over the Northeast or are all known examples found only within our study area. Finally, the resolution of the vegetation classification and the ecological variability of each community – is the classification so specific that a few examples of each captures variability, or is it a broad classification in which many examples of each community type should be protected to guarantee representation of several varieties (Groves and Valutis 1999).

River basin – an area of more than 1000 square miles that drains to a single river.

Sedimentary – Designating rocks and other inorganic materials formed from sediment deposited after transportation from its original position. *

Special concern – special concern species are native species which have been documented by biological research or inventory to have suffered a decline that could threaten the species if allowed to continue unchecked, or which occur in such small numbers or with such restricted distribution or specialized habitat requirements that they could easily become threatened within Massachusetts.

Special Elements – Rare, threatened, and endangered plants and animals; uncommon landforms such as ledges, caves, and eskers; and rare and exemplary natural communities are all special elements that any reserve design should take into consideration. Rare natural communities and habitat for rare species is not always the most species diverse habitat, so targeting these locations for protection while neglecting other areas is not a sound approach to overall habitat protection. Locating hotspots where many special elements occur together one way of maximizing protection effort. A balanced reserve design must aim to protect special features where possible, while remaining focused on the coarser scale need for landscape connectivity.

State-listed – A state-listed species is one that has been officially listed under the Massachusetts Endangered Species Act's list as Threatened, Endangered, or of Special concern. Any native species also listed as Endangered or Threatened by the US Fish and Wildlife Service is also included on the state list.

Subbasin – an area between 100 and 1000 square miles that drains to a single water course

Subwatershed – an area of less than 10 square miles that drains to a single stream

Surficial geology – the unconsolidated earth materials which overlay bedrock and lie directly beneath the soil layer. The surficial geology layer consists of glacial deposits, gravel, sands, silts, and clays.

Threatened – threatened species are native species which are likely to become endangered in the foreseeable future, or which are declining or rare as determined by biological research and inventory.

Transects – a line either physical or imaginary that is established along which measurements will be taken that provide information about a species of interest. Transects can be revisited at regular intervals in order to detect changes to populations of species over time.

Umbrella – species that generally cover large and ecologically diverse areas in their daily or seasonal movements; protection of enough of their habitat to assure a viable population of these organisms would provide habitat and resources to many other species more restricted in range.

Watershed – an area between 10 and 100 square miles that drains to a single water course

Wilderness quality indicator - species that are sensitive or vulnerable to human disturbance and thus require remote, wilderness habitat.

Appendix VII - Safety considerations when doing field work

When conducting fieldwork, it is important to observe a few basic safety guidelines that are described below. Depending on the type of work, the area that will be surveyed, and the weather, special safety equipment may be appropriate. These might include personal protective clothing such as coveralls, boots, sunglasses, insect repellent, sunscreen, hats, wetsuits, gloves, respirators, personal flotation devices. Even after appropriate equipment has been gathered together, make sure that everyone working with you knows how to use it.

Before Going Outdoors:

1) Make sure that someone besides yourself and the people working with you know where you will be going and when. In addition, work with a partner so that if an injury occurs, one of you can go for help. Ask everyone you will be working with to inform you of any medical conditions or allergies they have before leaving to do fieldwork.
2) Become familiar with the areas in which you are inventorying. If an emergency occurs, you will want to get to the nearest phone or medical center as quickly as possible.
3) Dress properly for fieldwork and weather conditions. Use clothing that is strong and will not rip easily. Always wear pants, long sleeve shirt, a hat, and good hiking shoes or boots. Make sure you are prepared for rain and unexpected dip in the temperature. It is good to carry all of your equipment in a backpack or large fanny pack.
4) Assemble and bring a First Aid Kit that Contains the Following:
    a) Adhesive and cloth bandages
    b) Antiseptic spray or ointments
    c) Surgical tape
    d) Hydrogen peroxide
    e) Tweezers or forceps
    f) Cotton balls
    g) Aspirin or non-aspirin pain reliever
5) Insect bites / stings– Determine if you or anyone accompanying you is allergic to insects, bees, or spiders and bring appropriate antidotes or medicine to arrest the allergic reaction.
6) If you plan to visit private property, always obtain permission to enter the land.

Once in the field:

1) If a coworker or volunteer gets an insect bite that becomes alarmingly swollen, immediately seek medical attention. Wearing long-sleeves, pants, a hat, and sometimes a mosquito net will keep insects away from you.
2) Ticks – Ticks are very abundant in grassy and woody areas and will attach themselves to humans if given the chance. Wear clothing that makes it difficult

for ticks to access your skin. Tuck your pants into your socks and wear long-sleeves. At the end of the day of fieldwork check for ticks (especially hair-covered areas). If you do find a tick attached to you, do not yank it out. Instead, grab it with forceps or tweezers as close to the skin as possible and gently pull it out. Immediately disinfect the area afterwards. Deer ticks, present in New Hampshire and Massachusetts, can carry and spread Lyme's disease. Consult field guides if you would like to learn how to identify Deer ticks. Initial symptoms of Lyme's disease are chills, fever, and general malaise. Treatment should occur quickly and requires a shot and antibiotics. If not treated, the early symptoms will go away to be replaced with some or all of the following problems: severe and chronic muscle pain, arthritis, neurological symptoms, severe pain, fatigue, depression, heart, eye, respiratory, and gastrointestinal problems

3) Bring plenty of water and food in case you get lost. Make sure to stay hydrated during the course of the day, especially if you are hiking long distances.
4) Do not take any unnecessary risks when in the field. Stay away from ledges, ravines and other environmental hazards.

Appendix VIII - Geographic Information Systems (GIS)

When working in the field of natural resources or wildlife habitat conservation, maps are an extremely important component of most projects. For this reason, GIS is a technology of which your organization should take advantage. The section below entitle “Should you use a GIS?” will provide a basic introduction to GIS. It is followed by some more concepts relevant to GIS as well as a description of the GIS resources that are available in Massachusetts and New Hampshire.

Should you use a Geographic Information System?

A Geographic Information System (GIS) may be very useful to your project. Below is a brief description of exactly what a GIS is, as well as some of the things to be considered before deciding to use a GIS.

What is a Geographic Information System?

A GIS is a system for capturing, managing, manipulating, analyzing and displaying data which is spatially referenced.

In a GIS, information such as soil types, location of vernal pools, wetland boundaries, parcel boundaries, and habitat types can be stored in "data layers". One of the strengths of GIS lies in its ability to connect each data layer to a database of information. For instance, the soil data layer can contain many different pieces of information such as organic matter content, particle size, or whether or not a particular area is prime farmland.

Another strength of GIS is that you can overlap one data layer onto another one to produce composite maps. Hydrological data layers (streams, ponds, rivers, lakes, and floodplains) can be shown along with roads, locations of houses, topographic contours, and parcel boundaries (where available). Planners can consider these multiple pieces of information when trying to make land use decisions.

Maps are the traditional medium used to convey GIS information, Maps are often the most important component of inventories. They efficiently communicate complicated relationships to the viewer. Maps are crucial in habitat and natural resource inventories because they elucidate the spatial relationships between different resources. They allow one to convey very complex sets of data in a very simple manner. In addition, if they are carefully crafted, the map portion of an inventory can be a joy to study and experience. Finally, with a GIS system, you can also perform sophisticated database and spatial analysis. The results can be shown either in map, table or graph format.

Should you use GIS?

Many town, state, and non-profit organizations are using GIS to organize spatial information. As a result, it is becoming easier and less costly to create and support GIS systems than before. In addition, there is a lot of high quality data that is currently available for free and can greatly aid inventories.

GIS is a very powerful tool that has recently become widespread in use. While very powerful, GIS software is quite complex and requires a significant investment of time and funds in order to create such a system. Much of this investment must come at the outset, when you are first establishing a GIS system and the knowledge of how to use it. To set up a simple GIS system a computer, color printer, and software must first be purchased. Then the GIS database must be collected and organized. A part-time or full-time GIS specialist is usually sufficient to set up, collect, and organize a GIS database. Once this initial work has been accomplished, the amount of time needed to maintain the GIS database will decrease.

The investment needed to make use of a GIS system will vary. For some inventories it will be appropriate to hire a GIS specialist to create the GIS database. They will be paid to do all the work for you and will create the requested products. Those involved on the project will never have to learn GIS and once the project is over, the GIS database will not need to be maintained. This is a short-term option that should be used if the project is very limited in scope and the funding situation is such that only a modest amount of money can be spent on GIS resources. If this approach to GIS is used over the long-term, it will be more expensive than developing an "in-house" GIS capability in the first place. Take this into consideration.

If your town or group will continue to use GIS as a resource for the long-term, you should strongly consider developing your own GIS database. Often, a GIS will first be used by the assessors office in order to create a digital parcel map of the town. Once this initial investment has been made, often other groups (Conservation Commission) or one motivated individual will initiate other projects that make use of GIS. This will allow the project to create maps and conduct analyses whenever needed. It will also allow regular updates to the natural resource or habitat maps as additional information is gathered. Once the system is set up and running, a part-time or full-time GIS specialist will be required to manage the system. MassGIS has published a document entitled, "Getting Started With GIS: A guide for municipalities". This document provides basic information to municipalities interested in learning more about or setting up a GIS. The guide can be downloaded from www.state.ma.us/mgis/munigis.htm.

GIS Software

While there are many GIS software packages that exist, the software produced by ESRI (Environmental Systems Research Institute) are by far the most widely used GIS packages. Other GIS packages such as MapInfo, MapFactory, IDRISI, GRASS, and MOSS are also available and are usually less expensive. However, the vast majority of data and your peers will be using ESRI GIS products, and this must be taken into consideration. Most of us are familiar with the various versions of ArcView 2.0 – 3.x and this is the software that you will see in most local or small scale applications. However, ESRI recently overhauled its software and is now selling a suite of products called ArcGIS. While the same functionality exists and many new tools were added to these products, there are many of us who spent years developing projects using the older versions of ArcView. For this reason, it will take some time before the GIS community has moved to the newer versions of the ESRI products.

ArcView still exists in its most current version ArcView 8.2. If you are just starting to build a GIS, you would be well advised to immediately move to the ArcGIS suite of products and purchase ArcView 8.x to start. You could purchase ArcView 3.x but it is very likely that you would have to migrate to ArcView 8.x in the near future along with the rest of us. For more information on GIS products contact a GIS specialist, ESRI, or MASSGIS or GRANIT.

What is MassGIS?

The following descriptions of MassGIS were taken directly from the MassGIS website. MassGIS is the Commonwealth's office of geographic and environmental information, within the Massachusetts Executive Office of Environmental Affairs (EOEA). Through MassGIS, the Commonwealth has created a comprehensive, statewide database of spatial information for environmental planning and management. Recent legislation has established MassGIS as the official state agency assigned to the collection, storage and dissemination of geographic data. The legislation gives MassGIS the mandate to set standards for geographic data to ensure universal compatibility.

The evolution of geographic information systems in the Commonwealth of Massachusetts is not unlike its development in other states. A lead agency, in this case the Executive Office of Environmental Affairs (EOEA) (http://www.magnet.state.ma.us/envir/eoea.htm), perceived an opportunity to meet its goals through development of a statewide GIS. Three related feasibility studies were funded, a plan for development was negotiated with EOEA's agencies, and that plan was implemented over a five year period, creating the Massachusetts Geographic Information System - MassGIS - in the late 1980s. As a result, EOEA has become a leading provider of digital geographic information within the Commonwealth and among Massachusetts public agencies using geographic information technology. You can obtain more information about MassGIS as well as download GIS data from the website, http://www.state.ma.us/mgis.

What is the NH GRANIT GIS database?

New Hampshire's GIS database is known as GRANIT (Geographically Referenced Analysis and Information Transfer). It is a collaborative effort between the Office of State Planning, the University of New Hampshire, and several other state, federal, and non-profit agencies. GRANIT offers many GIS data layers on a statewide level, many of which are very useful when conducting a natural resources or wildlife habitat inventory. You can obtain more information on GRANIT as well as download GIS information from the website, www.granit.sr.unh.edu.

Getting GIS maps and assistance with GIS?

Many GIS maps can be obtained from MassGIS and GRANIT related to natural resources or wildlife habitat. The best way to familiarize yourself with this information is to visit their websites. The MassGIS list of available datalayers can be accessed at the following website, http://www.state.ma.us/mgis/laylist.htm while the GRANIT list of available data layers can be found at

http://www.granit.sr.unh.edu/cgi-bin/load_file?PATH=/data/datacat/index.html . If the above GRANIT link does not work, look for links to the GRANIT data catalog.

Massachusetts and New Hampshire GIS

The Massachusetts Geographic Information Council (MGIC) is a forum to share and promote the use of high quality geographic information in physical, social, and economic projects in Massachusetts. They hold monthly meetings from September through May with presentations by Geographic Information professionals. To contact MGIC call MassGIS at (617) 626 1057.

The MassGIS website has a page of information specifically designed for municipalities interested in learning more about GIS (http://www.state.ma.us/mgis/munigis.htm). Many municipalities have developed GIS capabilities along with the Massachusetts Regional Planning Commissions, the Nashua River Watershed Association, other non-profit organizations in Massachusetts, and the many private vendors listed in the MassGIS website (http://www.state.ma.us/mgis/muniserv.htm).

In New Hampshire, many of the same types of groups as in Massachusetts can help provide support if you are just establishing a GIS. Training in GIS is available from NH Community Technical College and UNH Cooperative Extension. Visit http://www.granit.sr.unh.edu/cgi-bin/load_file?PATH=/resources/training.html to learn more about these courses.

Other GIS information

Digitizing – This is a process that is used to convert existing paper maps into digital maps that are spatially referenced and can be overlaid with other data layes. Usually maps are converted using a digitizing table (an electronic tracing device) or large scanners. Digitizing is usually very time-consuming.

GPS (Global Positioning System) – GPS is a fantastic tool that aids in fieldwork and the creation of high quality environmental data sets. A GPS is a portable device that allows you to locate yourself anywhere on the earth. The GPS locates several of a network of satellites in order to find its position. GPS systems vary in their accuracy from ±100 ft to ± 1 inch, and the cost of these systems also varies tremendously (~$200 - $30,000). Data points or travel tracks can be collected in the field and then downloaded into the GIS after field work is done, allowing you to organize the work and data that you are collecting in a spatial way.

Map Scale - Scale is the relationship between map distance and ground distance. This information can be conveyed in two ways: a ratio or a scale bar. The ratio 1:1000, for example, tells you that one unit on the map is equivalent to 1000 units on the ground (1 inch = 1000 inches or 1 meter = 1000 meters). We have all seen and made use of scale bars on maps. Scale bars depict a distance such as a mile on the map so that the map user can determine distances.

The non-intuitive terms of small, intermediate and large scale are often used in relation to maps. A “small” scale map (1:1,000,000) shows a large geographic area on the map and the number on the other side of the colon in the scale is large. A “large” scale map, on the other hand shows a small geographic area on the map and the number on the other side of the colon in the scale is small. If you can use this term correctly, you will be better of than most!

Satellites – Digital information from satellites and aerial photography can be displayed in a GIS as an image. These images can be extremely useful to orient people to a study area. The resolution of satellite images is improving all the time and is currently able to show the world in roughly 1 meter blocks. In addition, different parts of the light spectrum can be collected (visible, infrared, and ultra-violet) which allows “remote-sensing” specialists to examine things such as plant productivity and soil moisture.

Projections – The earth is a sphere! Maps and computer screens are flat! Whenever you display a spherical object on a flat screen, distortions will take place. There are many different “map projections” that depict the surface of the earth or a portion of the surface of the earth as flat. Different projections seek to minimize different types of distortion such as conformality, direction, scale, and area. If you work with GIS data, this is a term that you will begin to hear and learn about. GIS data can arrive on your computer in different projections and will have to be re-projected before you can overlay it with other GIS data. To learn more about projections visit

http://www.colorado.edu/geography/gcraft/notes/mapproj/mapproj_f.html.

Source of data and metadata – Metadata is literally data on the data. A metadata library should exist alongside every GIS database so that users can quickly learn things such as how the data layers were made, to what scale it is appropriate to use the data, and how old the data is. Most large datasets have good metadata.

Appendix IX - Important Topics in the Field of Conservation Biology

Biodiversity

What exactly is biodiversity? The simplest definition is, the diversity of life. Biodiversity is all of the different plant and animal species that live in an area. However, biodiversity also refers to the genetic diversity found within each species. It also refers to the diversity of ecosystems that exist in an area. Biodiversity is not just one number that can be determined for every area on earth. Here, we briefly discuss the term biodiversity so that you can understand it better.

In 1987, the Office of Technological Assessment (OTA) made the first attempt to create a more precise definition for "biodiversity" stating the following:

"Biological diversity refers to the variety and variability among living organisms and the ecological complexes in which they occur. Diversity can be defined as the number of different items and their relative frequency. For biological diversity, these items are organized at many levels, ranging from complete ecosystems to the chemical structures that are the molecular basis of heredity. Thus the term encompasses different ecosystems, species, genes, and their relative abundance."

Despite the number of years that have passed since the OTA definition, subsequent definitions have not deviated significantly (Forman 1995, Perlman and Adelson, 1997, Convention on Biological Diversity 1992, Fiedler and Jain 1992, International Council for Bird Preservation 1992, Meffe and Carroll 1994, Hunter 1996). Most contain some version of the statement, "biodiversity is the variety of living organisms," and add that multiple hierarchically related levels of biodiversity, genes, species, and ecosystems should be considered. The consensus that surrounds this definition seems to demonstrate a sense of mutual agreement and understanding. However, not all scholars are content with the definition as it currently stands.

Reed Noss suggested in a 1990 paper that "biological diversity (biodiversity) means different things to different people" (Perlman and Adelson, 1997). This seemingly simple statement suggests the complex idea that a particular meaning of biodiversity is influenced by individual human values and experience. That is to say, biodiversity ceases to be a word denoting an objective thing, and becomes a concept that is subject to the variability of human values and culture.

Dan Perlman and Glenn Adelson (1997) believe that "the current definitions of biodiversity as 'genes, species, and ecosystems' fail both in theory and in practice" for multiple reasons.

1) Genes, species, and ecosystems are not discrete units but are always in the process of changing and evolving. 2) We are not economically able to assess biodiversity at the level of genes, species, and ecosystem. 3) There is also an incommensurability problem that exists. What, for example, is the relative worth of one species versus one ecosystem? 4) Perlman and Adelson also add that there is no distinction between the worth of components of biodiversity. For example, is an exotic, invasive species less important than a species indigenous to a region? While most would easily be able to answer this question, not many realize that they are making a value judgment in doing so.

E.O. Wilson and former Secretary Bob Durand at "Biodiversity Days"

It is crucial to realize that biodiversity is not only a word that defines an objective state of things, but that biodiversity is a concept, and as such, is subject to the different interpretations of individual people and cultures. There is no one inventory technique that will illuminate the patterns of biodiversity in your study region.

Rather, inventory of many separate components of biodiversity will give you a better understanding of the diversity of living things that exist within the study region.

If the term biodiversity is such a complicated one, what is a citizen in the Nashua River watershed to do if interested in protecting the habitat and natural resources that exist? Several bits of advice can be gleaned from the above discussion of the term biodiversity.

- Find out what biodiversity means to you. There is no one definition of biodiversity that is correct. Some people may choose to focus on the diversity of plant life in the watershed, while others will focus on the diversity of wetland habitat present. There is plenty of room for individuality when it comes to biodiversity.
- Given the inadequate resources (time, expertise, and funding) that exist to inventory biodiversity, any effort that is created at the local level will be very important in protecting the natural world around us.

- Acknowledge that there is no way to compare the loss of a wetland to the loss of a species from your area. You may choose to protect one element over another, but you must realize that this decision is informed by your values. Someone else may orient their efforts in another direction based on their own value system.
- Spend time creating your own value system concerning the biological world around us. Each of us will find different aspects of biodiversity that we value. Respect the way in which others choose to protect the biodiversity around them.

As you read this document, realize that there are many different ways that we can direct our actions to protect the natural world in which we live. Do not get overwhelmed by the many different inventory methods and assessment techniques described in this guide. Rather, ask yourself which of the many possible projects fit with your value system as it relates to the natural world. Answering the following questions may help you decide which of the techniques described you would like to undertake:

- How do I like to spend my time outdoors?
- What do I already know about the natural world around me? ("A Bioregional Quiz" found in Appendix XII is an eye-opening way to determine just how in touch or out of touch we are with the natural world in which we live.)
- What else do I want to learn?
- Are there any components of natural diversity (species, ecosystems, etc.) that are in need of protection in my area?

Reserve design theory

These descriptions are taken, with permission, from the Mass Audubon document entitled, "Focus areas for Wildlife Habitat Protection in the Nashua River Watershed" (Collins 2000). The concepts developed in the field of conservation biology and reserve design theory attempt to view protection in a hierarchical nature so that biodiversity is ultimately protected at multiple levels. A reserve refers to an area that is set aside for the protection of a particular species or set of species. Current reserve design theory is based on the core-corridor-buffer model which states that biodiversity at multiple levels will best be maintained in a system of large, undisturbed core areas, surrounded by buffer zones of limited disturbance, and connected by functional corridors for wildlife dispersal (Forman 1995). There are five basic principles of reserve design:

- Large blocks of habitat, containing large populations, are better than small blocks with small populations.
- Blocks of habitat close together are better than blocks far apart.

- Habitat in contiguous blocks is better than fragmented habitat.
- Interconnected blocks of habitat are better than isolated blocks.
- Blocks of habitat that are roadless or otherwise inaccessible to humans are better than roaded and accessible blocks. (Noss et al. 1999)

Large, roadless core areas perform many functions: they provide habitat for species that are extremely sensitive to human disturbance; they serve as "biological fortresses" against invasion of exotic species; and they can serve as control sites for ecosystem research in a landscape where human alteration is nearly all-pervasive (Noss et al. 1999). Smaller core areas serve as secondary habitat and as stepping stones for movement of individuals and populations. Buffers are areas of limited human presence surrounding core areas. These buffers serve as areas of compromise between conservation and human use and can include land uses such as farms, orchards, athletic fields, and low-density residential zones.

Placing pressure on the goals of maintaining contiguity are the many land uses that encourage fragmentation. Mass Audubon Society and others have identified habitat fragmentation as one of the state's most significant threats to wildlife habitat integrity. Fragmentation, the process of dividing natural lands into smaller and smaller units, is destructive in many ways; it:

- Limits feeding area of animals;
- Decreases area of interior habitat;
- Disturbs natural migration routes;
- Limits genetic interaction;
- Inhibits dispersal and recolonization after local extinction; and
- Restricts scale of natural disturbance regimes.

Depending on the mobility and sensitivity of a given animal species, an insurmountable barrier could be a highway such as Route 2 or a smaller town road, a strip development of buildings and parking lots, a residential cul-de-sac, or a corn field. Plant response to ecological barriers depends largely on habitat requirements and dispersal mechanisms of individual species, but impacts on animals such as pollinators indirectly affect plants. Fragmentation favors habitat generalists and tends to reduce the populations of larger predators. Overabundances of some species can have far reaching impacts on the landscape, as in the case of white tailed deer: their browsing directly impacts diversity and structure of the shrub layer in many of our forests, degrading shrub habitat to the point that heavily browsed areas host fewer shrub-nesting bird species (McShea and Rappole 2000). Increased fragmentation also leads to decreased populations of large carnivores. The removal of top predators can cause the population boom of smaller carnivores no longer competing with or hunted by top carnivores, a process called meso-predator release. Increased populations of mesopredators, such as raccoons and skunks, can negatively impact small mammals, amphibians, birds and their eggs.

A riparian area allowed to follow its natural course – an example of a landscape level process being maintained

Another major threat to wildlife habitat in Massachusetts is the invasion of exotic plant and animal species. "Invasives" are invasive due to dispersal and growth habits (and lack of pathogens and browsers) that allow them to outcompete native plants, thus depressing populations of native plants, and creating a homogenized natural community which is of reduced habitat value to native animals. Seeds of invasive plants disperse along roads and pathways, carried by wind or with vehicle and foot traffic. One small road through an otherwise contiguous forest can serve as a conduit for the introduction of invasive plants. Thus habitat fragmentation contributes directly to the spread of invasive plants.

Edge habitat, or the boundary area between two distinct vegetation types, such as forest and grassland, is often touted as a contributor to biodiversity since many different species make use of such transition zones between cool, shady, tall canopy forest and warm, sunlit openings. In truth these are ecologically important and diverse areas for plants and invertebrates and edges are heavily used by animals taking advantage of the openings for food and the forest for cover. This information is often used as support for logging or other land clearing operations with the reasoning that if edge is diverse, and diversity is good, more edge must be better. Unfortunately, edge is a common characteristic of suburban development, and more edge only means larger populations of the same species that currently make use of the watershed's already abundant edge habitat.

Interior is not exclusive to forests. Grassland, a rapidly declining habitat type in the northeast, is unique breeding habitat for many bird species that require not just a small grassy opening, but large expanses of treeless meadow. Any increase in edge comes at the expense of interior – of any community type including forest, grassland, water body, etc. – and impacts negatively on the species that specialize in making use of that interior habitat. Scarlet tanagers, birds known to exist in interior forest habitat, have been shown to decrease in more fragmented landscapes, where there is a concurrent increase in avian and mammalian nest predators and cowbirds, a nest parasite (Rosenberg et al. 1998).

Thoughtful reserve design will:

- Allow for the long-term integrity of landscapes and ecosystems by maintaining functional relationships at all levels of biological organization, allowing individual organisms to obtain nutrients, shelter, security, and protection from pathogens, parasites, and pollutants;
- Provide animal populations sufficient area to maintain genetic variability;
- Maintain connectivity to allow for recolonization after local extinctions;
- Maintain the functional relationships between associated species such as predator / prey, parasite / host, and plants / pollinators-seed dispersers; and
- Protect the landscape level processes such as floods, weathering, and migration (Scott et al. 1999).

Landscape Scale Conservation Planning

Perhaps the leading proponent of landscape-scale planning for the restoration and protection of naturally functioning ecosystems in North America is the Wildlands Project. The Nature Conservancy, with their Ecoregional Planning process, is also working on identifying important areas for land protection on the regional scale. These two groups often work with much larger land areas than we are analyzing in Pepperell, such as the Wildlands Project's effort to identify and protect grizzly bear habitat from Yellowstone National Park to the Yukon Territory in Canada. However the techniques developed through their large-area planning efforts, and the lessons learned can be borrowed and adapted for this analysis. In an ecoregional reserve design completed in Oregon and California, Noss et al. (1999) state four goals to be met by a reserve system; to:

- Represent all kinds of ecosystems, across their natural range of variation, in protected areas;
- Maintain viable populations of all native species in natural patterns of distribution and abundance;
- Sustain ecological and evolutionary processes; and
- Maintain a conservation network that is resilient to environmental change.

Noss and others have developed a three-prong approach to identifying specific areas that go into a reserve design to meet those goals:

- Protection of special elements, such as rare species hotspots, old-growth forests, and critical watersheds for aquatic biota;
- Representation of all habitats and vegetation types within a network of reserves; and
- Meeting the needs of particular focal species, especially those that are area-dependent or sensitive to human activities.

If you are not familiar with many of the terms used above such as focal species and special elements, please refer to the Glossary in Appendix VI.

Having identified focal species from a number of taxa, the next step is to consider the primary habitat requirements of those species. These required landscape elements, be they large water bodies, ledge-filled slopes, or red maple swamps, then become the basic units of a reserve network.

This introduction provides a brief overview of the theory and practice of reserve design. Excellent references include Continental Conservation: Scientific Foundations of Regional Reserve Networks by Soule and Terbourgh, The Science of Conservation Planning by Noss, O'Connell, and Murphy, and Land Mosaics: The Ecology of Landscapes and Regions by Richard Forman.

Appendix X – Funding sources

Two tables are presented here. The first table presents information that was initially gathered by George Zoto (EOEA South Coastal Watersheds Team Leader) and compiled into the "EOEA Grant Matrix". Additional material and further edits were made by James DeNormandie in preparation of the Citizen's Guide. The second table contains different funding opportunities, often from the same state or Federal agency described in the first table. However, this information was taken from an access database describing Massachusetts and Federal funding opportunities. Both of these tables were made available by Jo Anne Carr (Nashua River watershed team leader – Massachusetts Watershed Initiative).

Table 1. Grants and Funding Opportunities

AGENCY GRANT OPPORTUNITY	ELIGIBILITY	AVAILABLE FUNDS	CONTACT	WEBSITE	DESCRIPTION
Executive Office of Environmental Affairs (EOEA)					
Outdoor Classroom Program	Educational Institution	$2,500 maximum	Melissa Griffiths (617) 626-1114	http://www.comm-pass.com	This funding opportunity is designed to support efforts at the Commonwealth's schools and public spaces to utilize the nearby outdoor natural environment to teach students the principles and ethics of environmental protection.
Watershed Initiative, Volunteer Monitoring Grants	Watershed Organizations/Associations, Citizen Water Quality Monitoring Groups	$10,000 maximum	John Clarkson (617) 626-1175		To support volunteer groups that monitor water quality
Biodiversity Days Grants	All	$400 per municipality	Cynthia Cormier (617) 626-1116		
EOEA, Division of Conservation Services (DCS):					
Self-Help Program	Municipalities	$500k maximum	Jennifer Soper, (617) 626-1015, jennifer.soper@state.ma.us	http://www.state.ma.us/envir/conservation/selfhelp.htm	This state program pays for the acquisition of land, or a partial interest (such as a conservation restriction), and associated acquisition costs such as appraisal reports and closing costs.

AGENCY GRANT OPPORTUNITY	ELIGIBILITY	AVAILABLE FUNDS	CONTACT	WEBSITE	DESCRIPTION
Federal Land and Water Conservation Fund	Municipalities, special districts and state agencies	Unsure but can be up to $500,000, perhaps more	Jennifer Soper, (617) 626-1015, jennifer.soper@state.ma.us	http://www.state.ma.us/envir/conservation/lw.htm	The Federal Land & Water Conservation Fund (P.L.88-578) provides up to 50% of the total project cost for the acquisition, development and renovation of park, recreation or conservation areas. Municipalities, special districts and state agencies are eligible to apply.
Urban Self-Help Program	Municipalities	$500k maximum	Joan Robes, (617) 626-1014, joan.robes@state.ma.us	http://www.state.ma.us/envir/conservation/urban.htm	The Urban Self-Help Program was established in 1977 to assist cities and towns in acquiring and developing land for park and outdoor recreation purposes. Grants are available for the acquisition of land, and the construction, restoration, or rehabilitation of land for park and outdoor recreation purposes such as swimming pools, zoos, athletic play fields, playgrounds and game courts. Access by the general public is required.

Department of Environmental Management (DEM)

Lake and Pond Grant Program	Municipalities, Watershed Organizations/Associations, Lake and Pond Associations	$10,000 maximum	Steve Asen (617) 626-1353	www.state.ma.us/dem/grants.htm	Protection, preservation and enhancement of public lakes and ponds.
Recreational Trails Program	Municipalities,State Government/Agency,Interstate Agency,Non-profit Organization	$2,000 - $20,000	Peter Brandenburg (617) 727-3180 x655	www.state.ma.us/dem/grants.htm	The “Recreational Trails Program Grants” provides funding for a variety of trail projects.
Greenways and Trails Demonstration Grants Program	Municipalities, Regional Planning Agency, Non-profit Organization	up to $5,000 (up to $10,000-multi town)	Jennifer Howard (413) 586-8706	www.state.ma.us/dem/grants.htm	Support innovative projects which advance the creation and promotion of greenway and trail networks throughout Massachusetts.
Massachusetts Forests and Parks Americorps	Municipalities, Non-profit Organization	Work project	Peter Brandenburg (617) 626-1453	questions@americorps.org	

Department of Environmental Protection (DEP)

319 Nonpoint Source Grant Program	Any	$20,000 - $200,000	Beth McCann (617) 292-5901		

AGENCY GRANT OPPORTUNITY	ELIGIBILITY	AVAILABLE FUNDS	CONTACT	WEBSITE	DESCRIPTION
604bWater Quality Management Planning Grant Program	Regional Planning Agency,Local Government,Conservation District,Municipalities	$30,000 - $60,000	Gary Gonyea (617) 556-1152		
Community Septic Management Program	Municipalities	Optional Plans $100k, or $220k	Regional DEP		
Municipal Recycling Grant Program	Municipalities	No restrictions,(previous $44-$121k)	Brooke Nash (617) 292-5984		
104(b)(3)Wetlands and Water Quality Grant Program	Non-profit Organization, Watershed Organizations/Associations, Regional Planning Agency***	To Be Determined	Gary Gonyea (617) 556-1152		
Research and Demonstration Grant Program	Any	To Be Determined	Arthur Screpetic, (508) 767 2875		To conduct research relative to water pollution control and other studies to ensure cleaner rivers, lakes, and streams.
Source Water Protection Technical Assistance/Land Management Grant Program	Public Water Systems, Regional Planning Agencies, Conservation Districts, Land Trusts, Citizens' Groups, Business Associations, Volunteer Town Boards and Commissions, Educational Institutions, Watershed Organizations, State Agencies	$45,000 maximum	Kathy Romero (617) 292-5727	www.state.ma.us/dep/brp/dws/grants.htm	TheSourcewater Protection Grant Program provides funding to develop and implement actions that will help protect sourcewater supply resources.
Wellhead Protection Grant Program	Community and municipal public water systems and non-transient non-Community public water systems that serve schools	$45,000 maximum	Catherine Sarafinas (617) 556-1070	www.state.ma.us/dep/brp/dws/grants.htm.	The Wellhead Protection Grant Program provides funding to public water systems and municipalities for developing and implementing wellhead protection projects and plans.
Aquifer Land Acquisition Program	Water Suppliers, Municipalities	$8,000,000	Joseph McNealy (617) 556-1068		
Clean Water State Revolving Loan Fund (SRF) Program	Municipalities	$200 Milliion	Steven McCurdy (617) 292-5779		

AGENCY GRANT OPPORTUNITY	ELIGIBILITY	AVAILABLE FUNDS	CONTACT	WEBSITE	DESCRIPTION
Community Septic Management Program	Municipalities	$200,000 maximum per town	Pamela Truesdale (508) 946-2881		
Hazardous Waste Sites Technical Assistance Program	Municipalities	$10,000 maximum	Patti Mullan, (617) 556 1018		For hiring experts to review assessment and cleanup reports and educate the public about these sites.
Massachusetts Drinking Water SRF Program	Municipalities	$100 Million	Steven McCurdy (617) 292-5779		

Massachusetts, Department of Fisheries and Wildlife and Environmental Law Enforcement (DFWELE)

Urban Rivers Small Grants	Municipalities, Non-profit Organization	$18,000 maximum	Patricia Sheppard (617) 626-1541		
Riverways Small Grant Programs	Municipaliities, non-profit organizations,	$500 - $5000 typically	Eileen Goldberg (617) 626 1546	www.state.ma.us/dfwele/River/rivSmallgrnts.htm	Projects that substantially advance some aspect of river, stream, or adjacent land protection or restoration.
Clean Vessel Act Grants	Municipalities, Marinas	$50,000 maximum	Vin Malkowski (508) 563-1779		

Massachusetts Environmental Trust:

New Horizons Program	Nonprofit organizations, institutions of higher learning, the private sector, municipalities, government agencies, and individuals (if apply through an organization capable of carrying out the fiscal responsibilities for the program implementation).	$100,000 (available)	Robbin.Peach@state.ma.us, (617) 727-0249	www.agmconnect.org/maenvtr7.html.	This program seeks to address previously unexamined environmental issues related to water resources.
Youth in Environmental Philanthropy Program	Organizations capable of developing, implementing, and overseeing a youth-led environmental philanthropy program.	$50,000 (available)	Robbin.Peach@state.ma.us, (617) 727-0249	www.agmconnect.org/maenvtr7.html.	This new initiative seeks to encourage youth involvement and leadership in environmental grantmaking throughout the Commonwealth

AGENCY GRANT OPPORTUNITY	ELIGIBILITY	AVAILABLE FUNDS	CONTACT	WEBSITE	DESCRIPTION
Environmental Education Program	Schools or school districts, nonprofit organizations, community foundations, institutions of higher learning, municipalities, and government agencies.	$100,000	Robbin.Peach@state.ma.us, (617) 727-0249	www.agmconnect.org/maenvtr7.html.	This program seeks to further place-based environmental education in communities across the state by encouraging collaborative efforts at the regional level
Environmental Monitoring Program	Nonprofit organizations, institutions of higher learning, the private sector, municipalities, government agencies, and individuals (if apply through an organization capable of carrying out the fiscal responsibilities for the program implementation).	$100,000 (available)	Robbin.Peach@state.ma.us, (617) 727-0249	www.agmconnect.org/maenvtr7.html.	This program offers support for environmental monitoring efforts throughout the Commonwealth that have direct and demonstrable management implications for water-related resources or habitats.
Biodiversity Program	Nonprofit organizations, institutions of higher learning, the private sector, municipalities, government agencies, and individuals (if apply through an organization capable of carrying out the fiscal responsibilities for the program implementation).	$100,000 available	Robbin.Peach@state.ma.us, (617) 727-0249	www.agmconnect.org/maenvtr7.html.	To protect the state's biodiversity by supporting efforts to improve management practices and communication, special focus on threatened or endangered species and critical habitats
Unrestricted General Grants Program	Nonprofit organizations, community associations, civic groups, schools and institutions for higher education, research organizations, other philanthropies, municipalities, state-appropriated groups	$200,000 available	Robbin.Peach@state.ma.us, (617) 727-0249	www.agmconnect.org/maenvtr7.html.	This program is designed to support general environmental projects statewide with a focus on water and related resources.

Army Corps of Engineers (COE):

AGENCY GRANT OPPORTUNITY	ELIGIBILITY	AVAILABLE FUNDS	CONTACT	WEBSITE	DESCRIPTION
Planning Assistance to States Program (PAS)	State Government / Agency, Regional Planning Agency, Watershed Organizations / Associations	50% Match Required	Mike Gildesgame (617) 626-1371		
Flood Plain Management Services (FPMS)	Municipalities,State Government / Agency,Regional Planning Agency,Watershed Organizations / Associations	$50,000 - $100,000	Mike Gildesgame (617) 626-1371		
Environmental Protection Agency (EPA):					
Brownfields Economic Redevelopment Initiative	State Government / Agency, Municipalities, Local Government	Pilot Projects, $200,000 maximum	John Podgurski (617) 918-1209		
Sustainable Development Challenge Grants	State Government / Agency, Non-profit Organization, Local Government	20% Match (Required)	Rosemary Monahan (617) 918-1087		
Livable Communities Grant	All, except Private Landowner	$5,000 - $50,000 (20% Match Req.)	Rosemary Monahan (617) 918-1087		
Northeast Rural Water Association (NeRWA) Drinking Water Source Protection Assistance	Small public water systems that service less than 10,000 people.	Unsure	Contact MaryJo Feuerback, (617) 918 1578, feuerbach.maryjo@epa.gov		Through a grant by EPA, the Northeast Rural Water Association (NeRWA) offers assistance to small public water systems in MA, NH, and VT (servicing less than 10,000 people on its distribution system) for drinking water source protection. NeRWA is currently seeking areas in Massachusetts which would benefit from their services.
Hardship Grants Program for Rural Communities	Rural Communities	Grants or Technical Assistance	Tony DePalma (617) 918-1618		
Other Grant Programs					
New England Graassroots Environmental Fund	Non-profit Organization	$500 to $2,500	Ginny Callan (802) 223-4622, callan@grassrootsfund.org	www.grassrootsfund.org	To fund community involvement projects in a wide range of environmental issues including water related issues

AGENCY GRANT OPPORTUNITY	ELIGIBILITY	AVAILABLE FUNDS	CONTACT	WEBSITE	DESCRIPTION
NOAA Community-Based Restoration Grants					
Five Star Restoration Program	All	$5,000 to $20,000	Bob Johnson (301) 588-8994		
Trout Unlimited (TU) Embrace-A-Stream	Trout Unlimited Chapter	$10,000 maximum	Contact local TU Chapter		
Watershed Assistance Grants	Local Watershed Partnerships	$1,500 to $30,000	Vermont Office General Number (802) 223-3840	www.rivernetwork.org/howwecanhelp/howwag.cfm#wag	
Acorn Foundation Grants	Economic, Environmental and Social Justice Initiatives	$5,000 to $10,000	Common Counsel Foundation (510) 834-2995	www.commoncounsel.org	Projects dedicated to building a sustainable future for the planet and to restore a healthy global environment
Environmental Support Center Grants	Local, state, and regional organizations	$3,500 maximum	(202) 331 9700	www.envsc.org	To improve the environment by enhancing the health and well being of local, state and national organizations working on environmental issues. Various types of grants and loans.
The Dunn Foundation Grants	Upon receiving an invitation		(401) 941-3009	www.dunnfoundation.org	Supports projects that increases the effectiveness of local community organizations.
Watershed Assistance Grants, The River Network			Vermont Office General Number (802) 223-3840	www.rivernetwork.org/howwecanhelp/howwag.cfm#wa	To help local watershed partnerships and support their organizational development and long-term effectiveness
William P. Wharton Trust	Tax-exempt organizations with 501 (c) (3) status	$1,000 - $10,000	William P. Wharton Trust, C/O Choate, Hall, and Stewart, Exchange Place, 52 State St, Boston, MA 02109, Pearl E. Bell, Estate and Trust Administrator (617) 248 5000	www.state.ri.us/dem/programs/bpoladm/suswshed/grantgud/will_wharton_trust.html	The Trust provides a small number of grants that directly promote the study, conservation, and appreciation of nature. The Trust's objectives include: natural areas preservation, management techniques designed to improve environmental quality and species diversity, equipment or facilities that increase the effectiveneess of the application organization, and the creation of projects designed to foster an appreciation of and concern for wildlife and natural systems.

AGENCY GRANT OPPORTUNITY	ELIGIBILITY	AVAILABLE FUNDS	CONTACT	WEBSITE	DESCRIPTION
Community Based Restoration Program	All	$25,000 to $150,000	Chris Doley (301) 713-0174		

Table 2. Grants and Funding Opportunities

Administering Agency	Name of Program	Eligibility	Available Funding (as of 1998)	Contact	Purpose / Objective	Description
FSA with support from NRCS, CES, state forestry & local conservation district.	Conservation Reserve Program (CRP)	Educational institution	Funding for total of 36.4 million acres nationwide; $1.9 billion estimated for FY98; rental payments range up to $50K/fiscal year.	Local USDA Service Center, FSA Field office or State FSA office at 445 West St., Amherst, MA 01002. 413/256-0232. Internet at http://www.fsa.usda.gov/pas/prgfact.htm OR http://www.nhq.nrcs.usda.gov/CCS/This Week/NWK01-30.html	Voluntary land retirement program designed to encourage farmers to establish long-term resource conserving vegetative covers to reduce erosion, improve water quality and enhance wildlife habitat.	Landowner places environmentally sensitive land into 10-15 year contract in return for annual payments, landowner must then implement a conservation plan that establishes vegetative cover; additional incentive payments offered for certain activities (e.g. riparian buffers); one time only cost share grant up to 50% offered to establish the approved cover on eligible cropland; easement may be purchased in certain situations.
Local assessors approve application.	Chapter 61B: Open Space or Recreation Lands Tax Law	Non-profit organization, Educational institution	N/A	Local assessors office.	Land retained in its natural state to preserve natural resources or devoted primarily to recreation and open to the public.	Property assessed at up to 25% of fair market value and taxed at commercial rate corresponding to 75% decrease in property tax on enrolled acres; tax penalty for land use change; no penalty for ownership change.

MA DEM approves management plan if required by municipality; local assessors approve application.	Chapter 61A: Farmland Tax Law	Non-profit organization, Educational institution	N/A	MA DEM service forester at a regional office or MA DEM, Division of Forests & Parks, 100 Cambridge St., 19th Fl., Boston, MA 02202. 617/727-3180. Internet at http://www.magnet.state.ma.us/dem/div-f-p.htm	Provide property tax incentive for landowners willing to keep agricultural or forested land undeveloped and in production by following an improved agricultural or forest management plan.	Property assessed at a range of values set by statewide Farmland Value Advisory Commission, town chooses a rate within that range, decreasing property tax on enrolled acres; possible joint enrollment with Stewardship Incentive Program.
MA DEM inspects practices/activities; NRCS approves cost-share payment.	Forestry Incentives Program (FIP)	Private landowner, Conservation district, Non-profit organization, Educational institution	$6.6 million nationwide FY98; allocated to states based on eligible acreage, ownership patterns, growth potential.	MA DEM service forester at a regional office or MA DEM, Division of Forests & Parks, 100 Cambridge St., 19th Fl., Boston, MA 02202. 617/727-3180. Internet at http://www.nhq.nrcs.usda.gov/OPA/FB960PA/FIPfact.html OR http://willow.ncfes.umn.edu/coop/landp.h	Increase the nation's supply of timber products with emphasis on: sustained yield, cost effective forest improvement practices, enhancing all forest resources, multipurpose management of non-industrial private forest land.	Minimum 10 year contract providing cost share grant up to 65% to establish or improve forestland and stewardship practices; 3 different programs (FP 1-3) reflecting owner's goals. This program is also used to fund Massachusetts Stewardship Incentive Program.

MA DEM, Bureau of Forest Development; MA Forest Stewardship Coordinating Committee; Forest Legacy Committee.	Forest Legacy Program	Conservation district, Educational institution	$2 million FY98 nationwide; additional $2 million for project in WA state; MA received $501K FY 96.	MA DEM, Division of Forests & Parks, Bureau of Forest Development, 100 Cambridge St., 19th Fl., Boston, MA 02202. 617/727-3180 x685 OR USFS Cooperative Forestry - Forest Legacy Program, 201 14th St., SW, Washington, DC 20250. 202/205-1190. Internet at htt	Protect environmentally important non-industrial private forests threatened by conversion to non-forest uses; also seeks to preserve the traditional uses of forests as "working forests" not solely as protected areas.	Priority land and interests (i.e. easements, covenants, public access rights) are purchased at fair market value from NIPF landowners; USFS provides up to 75% total cost of planning, administration, acquisition and management; state and partner organizations provide balance and may use in-kind services; where interests are purchased, landowner retains ownership of the land while continuing forestry practices.
MA DEM, Division of Forests & Parks approves application and management plan; filed with local board of assessors.	Chapter 61: Forestland Tax Law	Non-profit organization, Educational institution	N/A	MA DEM service forester at a regional office or MA DEM, Division of Forests & Parks, 100 Cambridge St., 19th Fl., Boston, MA 02202. 617/727-3180. Internet at http://www.magnet.state.ma.us/dem/div-f-p.htm	Provide property tax incentive for private forest landowner to increase the quality & quantity of forest products under an improved forest management plan.	Property assessed at 5% of fair market value and taxed at commercial rate corresponding to 95% decrease in property tax on enrolled acres; possible joint enrollment with Stewardship Incentive Program.

MA DEM, Division of Forests & Parks with assistance from FSA & State Forest Stewardship Coordinating Committee.	Forest Stewardship & Stewardship Incentive Program (SIP)	Private landowner, Conservation district, Non-profit organization, Educational institution	$6.5 million from USFS nationwide FY98; MA expects $93K FY98 (SIP 1-9); also $12K in MDC Wachusett funds (SIP 1,2,5) and 35K to MA DFWELE from MA Open Space Bond Act 1996 (SIP 8).	MA DEM service forester at a regional office or MA DEM, Division of Forests & Parks, 100 Cambridge St., 19th Fl., Boston, MA 02202. 617/727-3180. Internet at http://www.magnet.state.ma.us/dem/dem.htm OR http://www.fs.fed.us	Encourage private landowners to protect/manage their forestland in ways that improve forest products, wildlife habitat, soil/water quality, aesthetics, recreation and open space preservation.	Using professional assistance, the landowner develops a 10 year Stewardship Plan that defines the owner's long-term objectives and activities to be accomplished; cost share funds up to 75% provided to implement a wide range of activities; 9 different programs (SIP 1-9) depending on defined goals.
MA DEM, Division of Forests & Parks; guidance from MA Recreational Trail Advisory Board	National Recreational Trails Funding Program	Local government, Private landowner, Non-profit organization,	$7 million nationwide FY98; MA received $226,673 FY96	MA DEM, Division of Forests & Parks, 100 Cambridge St., 19th Fl., Boston, MA 02202. 617/727-3180 x655.	Create & maintain a network of recreational trails for motorized and non-motorized use by the public.	Provides up to 80% total project cost of creating recreational trails; $1K minimum grant amount. This program may be used, in part, to fund the state Greenways & Trails Demonstration Grants Program.
MA DEM, Division of Resource Conservation, Bureau of Engineering, Office of Waterways	Rivers, Harbors & Inland Waterways Programs	Local government,	Yearly allocations as outlined in bond issue; maximum award $200K.	MA DEM, Division of Resource Conservation, Bureau of Engineering, Office of Waterways, 349 Lincoln St., Bldg. #45, Hingham, MA 02043. 617/740-1600. Internet at http://www.magnet.state.ma.us/dem/div-r-c.htm	Provide funds to communities for projects to improve rivers and harbors.	Grants up to 50% of total project cost to communities for projects on lakes, ponds and rivers as part of a watershed or floodplain management plan; Also provides technical assistance including design and construction services.

MA DEM, Division of Resource Conservation, Office of Water Resources	Lake & Pond Grant Program	Local government, Private landowner, Private organization,	$235K FY96; maximum $10K per project.	Lake & Pond Grants, MA DEM, Office of Water Resources, 100 Cambridge St., 19th Fl., Room 1904, Boston, MA 02202. 617/727-3267 x524. Internet at http://www.magnet.state.ma.us/dem/grants.htm	Protect, preserve and enhance public lakes and ponds by promoting the integrated use of watershed management, in-lake management, pollution prevention and education in order to provide long-term solutions.	Grant up to 50% total project cost is provided; includes the development of a lake/watershed management plan.
MA DEM, Office of Natural Resources	Greenways & Trails Demonstration Grants Program	Regional planning agency, Local government,	$100K/year; grants range $1K-3K (additional funds up to 5K if need demonstrated).	Greenways Planner, MA DEM, 136 Damon Rd., Northhampton, MA 01060. 413/586-8706. Internet at http://magnet.state.ma.us/dem/grants.htm	Promote the creation of greenways & trails as an effective means of protecting, connecting and providing access to many unique areas; support innovative projects that advance the creation and promotion of greenway & trail networks throughout MA.	Provides small grants up to $5K to support community based greenway & trails projects; favors projects which are feasible, produce tangible results, enjoy broad-based community support and will serve as models for other greenway and trail initiatives.

MA DEP, Bureau of Resource Protection	Water Quality Management Planning Grants (604b)	Interstate agency, Regional planning agency, Local government, Private landowner,	MA received $368K FY98; grant amounts range from $30K-50K.	604(b) RFR coordinator, MA DEP, Bureau of Resource Protection, Division of Municipal Services, 1 Winter St., 5th Fl., Boston, MA 02108. 617/292-5500. Internet at http://www.magnet.state.ma.us/dep/brp/wm/wmpubs.htm	Assist planning agencies and other eligible recipients in providing water quality assessment and planning assistance to local communities.	Federal government allocates funds to state, which must provide a 20% match; the state, in turn, allocates these funds to RPAs and local organizations; these funds are provided for water quality assessment/management planning, 1998 focus is on watershed based NPS assessment and/or planning projects that provide diagnostic information supporting MA DEP basin-wide water quality management activities.
MA DEP, Bureau of Resource Protection, Division of Municipal Services	Comprehensive Community Septic Management Program	Local government, Educational institution	$30 million for five years authorized by the MA Open Space Bond Act 1996.	MA DEP, Bureau of Resource Protection, Division of Municipal Services, 1 Winter St., Boston, MA 02108. 617/292-5500. Internet at http://www.magnet.state.ma.us/dep/brp/wwm/t5pubs.htm	Assist homeowners to comply with Title 5 and encourage communities to adopt a comprehensive approach to septic system management; provide capitalization funding to communities so they may provide low interest loans to homeowners through a revolving loan and betterment process.	Option 1: $20K planning grant provided to identify priority areas and adopt a regional or watershed approach to septic system management plans; once plan is approved a minimum of $200K in SRF funds is made available to provide betterment loans either community-wide or to a targeted area of high environmental impact. Option 2: community may simply apply for $100K in SRF funds in order to provide loans on either basis; funds also available to communities to provide loans funding sewer connections or alternative solutions.

MA DEP, Bureau of Resource Protection, Division of Municipal Services & MA Water Pollution Abatement Trust	Clean Water State Revolving Fund (SRF)	Interstate agency, Local government, Private landowner, Non-profit organization, Private organization, Educational institution	Recently funded at $150-200 million/year; funds can be transferred from DWSRF into CWSRF and vice-versa.	MA DEP, 1 Winter St., 5th Fl., Boston, MA. 02108. 617/292-5653 or MA Water Pollution Abatement Trust, 1 Ashburton Place, 12th Fl., Boston, MA 02108. 617/367-3900 x409. Also US EPA, Region I, JFK Federal Bldg., Boston, MA 02203. 617/565-3655. Internet at h	Provide a long-term, low cost source of financing for water pollution control requirements and water quality improvement activities. Traditionally employed to build/improve wastewater treatment plants, increasingly being used for control of nonpoint source pollution.	
MA DEP, Division of Municipal Services	Nonpoint Source Grant Program (319)	State Government, Interstate agency, Regional planning agency, Local government, Private landowner, Conservation district, Non-profit organization,	$5.8 million to EPA Region 1 FY98; MA received $1.2 million and has allocated $560K for local projects with $416K committed; grants range $7K-426K.	MA DEP, Division of Municipal Services, 1 Winter St., 5th Fl., Boston, MA. 02108. 617/292-5901 Interent at http://www.epa.gov/OWOW/NPS/sec319cwa.html OR http://www.magnet.state.ma.us/dep/brp/wm/wmpubs.htm	Implement nonpoint source management programs consistent with state NPS control plans well as update state NPS assessment reports and management programs.	Federal government allocates funds to states, which must provide 40% match, they, in turn, provide yearly grants for implementation projects designed to prevent, control, or abate NPS pollution as well as restore watershed resources; NOTE: a section on lake protection and restoration activities picks up funding for programs previously funded under section 314 of the CWA: the Clean Lakes Program.

MA DEP, Drinking Water Program	Drinking Water State Revolving Fund Set-Aside/Local Assistance	Local government, Private organization,	$40-60 million in funds combined from FY97 & FY98; funds can be transferred from DWSRF into CWSRF and vice-versa.	MA DEP, Drinking Water Program, 1 Winter St., 9th Fl., Boston, MA 02108. 617/292-5770 or US EPA, Region I, JFK Federal Bldg., Boston, MA 02203. 617/565-4721. Internet at http://www.epa.gov/ogwdw/sdwa/dwsrf.html OR http://www.magnet.state.ma.us/dep/brp/dws	Prevent drinking water contamination problems utilizing "set-asides" for the non-project use of state capitalization grant funds for a range of specific SDWA activities identified in the Act which encourage SWP and other state drinking water program activities.	Up to 15% of state's Drinking Water SRF may be set aside to provide loans for local assistance for any of the following 5 activities: acquire land/conservation easement for SWP, implement voluntary incentive-based SWP measures, establish and implement a wellhead protection program, initiate capacity development and delineate and assess for SWP through the State Water Assessment Program.
MA DEP, Office of Watershed Management	Clean Lakes Program	State Government, Interstate agency, Regional planning agency, Local government, Private landowner, Conservation district, Non-profit organization, Educational institution	$0 funding since FY95.	MA DEP, Office of Watershed Management, 1 Winter St., Boston, MA. 02108. 617/292-5901. Internet at http://www.epa.gov/OWOW/NPS	Identify and classify publicly owned lakes, establish methods/procedures to control pollution and restore quality of lakes.	4 types of grants: Lake Water Quality Assessment grants up to 50% match with $50K maximum/year to help states survey lakes; Diagnostic-Feasibility Study grants up to 70% match with $100K max to determine causes of pollution, evaluate remedies and recommend restoration methods; Restoration & Protection Implementation grants up to 50% match to implement results of feasibility study; Post Restoration Monitoring grants up to 70% match with $125K max to assess effectiveness.

MA DFA, Land Use Division; Agricultural Lands Preservation Committee; local conservation commissions.	Agriculture Preservation Restriction (APR)	Local government, Educational institution	$25 million for five years authorized by the MA Open Space Bond Act 1996 and $1.5 million through USDA's Farmland Protection Program.	APR Program Mgr., MA DFA, Central MA Office, 142 Old Common Rd., Lancaster, MA 01523. 508/792-7712. Internet at http://www.massgrown.org/apr_summ.htm	Keep farms in active commercial use by offering a non-development alternative to farmers; second generation farmers needn't sell farm to pay inheritance taxes while other farmers may purchase affordable farmland; contributes to clean air and water, wildlife, recreation, open space and scenic beauty.	State purchases development rights by paying the difference between fair market value and agricultural value of the land in exchange for a permanent deed restriction precluding any property use that may negatively affect farming practices. Farmer owns the land and retains the right to sell, lease or will it.
MA DFWELE, Division of Fisheries & Wildlife	Habitat and Land Protection Program	State Government, Local government, Private landowner, Conservation district, Educational institution	$20 million authorized by MA Open Space Bond Act 1996; roughly $4.5 million/yr. in past years.	MA DFWELE, Division of Fisheries & Wildlife, 100 Cambridge St., Boston, MA 02202. 617/727-3151. Internet at http://www.magnet.state.ma.us/dfwele/com/comhpl.htm	Protect the ecological integrity of the biological resources of the Commonwealth by preserving land for habitat.	Land purchased at fair market value will be owned and managed by the state and open for appropriate public use.
MA EOEA	Watershed Initiative/Capacity Building Grant	Regional planning agency, Local government, Private landowner, Non-profit organization, Private organization,	5 grants up to $50K each.	Watershed Initiative Grants Coordinator, MA EOEA, 100 Cambridge St., 20th Floor, Room 2000, Boston, MA 02202. 617/727-9800 x248. Internet at http://www.comm-pass.com.	Develop organizational strength for groups/partnerships involved in watershed stewardship, develop public support, work with EOEA Basin Teams and implement action plans.	Grant up to $50K administered over two-year period, requiring 1:1 match; in-kind services acceptable.

MA EOEA	Watershed Initiative/Massachusetts Communities Connected by Water	Regional planning agency, Local government, Private landowner,	$530K awarded 1996.	Watershed Initiative Grants Coordinator, MA EOEA, 100 Cambridge St., 20th Floor, Room 2000, Boston, MA 02202. 617/727-9800 x248. Internet at http://www.comm-pass.com.	Fund a collaborative effort establishing a watershed community council or similar body for the purpose of gathering data on priority pollution sources, organizing community efforts, conducting outreach with EOEA Basin Teams and other stakeholders.	Grant up to $150K administered over two year period providing funding on a 1:1 matching basis.
MA EOEA & MA DEP, Bureau of Resource Protection	Water Quality Cooperative Agreements (104)(b)(3)	State Government, Interstate agency, Regional planning agency, Local government, Private landowner, Conservation district, Educational institution	$20 million nationwide FY98; $394K estimated for MA during FY98.	MA DEP, Bureau of Resource Protection, Division of Municipal Services, 1 Winter St., 5th Fl., Boston, MA 02108. 617/292-5500. Internet at http://www.epa.gov/OWOW/WM042000.htm OR http://www.magnet.state.ma.us/dep/brp/wm/wmpubs.htm	Grants to stimulate & support the creation of innovative approaches to water pollution control, assessment & watershed protection support activities and implementation of the watershed protection approach, including source water protection.	Funds allocated to state, state agencies in turn provide funds for special studies, pilots and demonstrations up to 75% total project cost.
MA EOEA, Division of Conservation Services	Self Help Program	Local government,	Specified in bond issue; maximum award $500K.	MA EOEA, Division of Conservation Services, 100 Cambridge St., 20th Fl., Room 1405, Boston, MA 02202. 617/727-1552 x292. Internet at http://www.magnet.state.ma.us/envir/units.htm	Preserve land and water in their natural state especially unique natural, historical, cultural features or extensive water resources and to provide public access for passive recreation purposes.	Funds 52-70% of total project cost for land acquisition including ancillary acquisition costs; amount funded tied to community's per capita wealth.

MA EOEA, Division of Conservation Services	Urban Self-Help Program	Local government,	Specified in bond issue; maximum grant award is $500K.	MA EOEA, Division of Conservation Services, 100 Cambridge St., Room 1405, Boston, MA 02202. 617/727-1552 x544. Internet at http://www.magnet.state.ma.us/envir/units.htm	Preserve land and water resources in their natural state especially unique natural, historic, cultural and extensive water resources; develop and/or renovate outdoor public recreation facilities; provide public access for passive and active recreation purposes.	Community is reimbursed between 52-70% of total project cost for land acquisition and ancillary costs as well as design, construction and construction supervision of outdoor recreation facilities; reimbursement based on community's equalized valuation per capita decile ranking.
MA EOEA, MA DEP	Rivers Protection Act 1996	State Government, Interstate agency, Regional planning agency, Local government, Private landowner, Conservation district, Non-profit organization, Educational institution	$30 million bond authorization.	MA DEP, Bureau or Resource Protection, 1 Winter St., Boston, MA 02108. 800/266-1122. Internet at http://www.magnet.state.ma.us/dep/brp/ww/wwpubs.htm#river	Protect rivers through land purchase and by regulating activities within newly established wetland resource area known as the Riverfront Area.	$30 million bond authorization for direct acquisition of lands fronting on rivers and streams. EOEA to develop 25 year plan to protect and acquire open space fronting on rivers. MA DEP may use up to $100K/year of Massachusetts Environmental Trust funds for technical assistance to local conservation commissions.
MA Forestry Association; Management Plan developed by MA DEM.	Tree Farm Program	Local government, Private landowner, Educational institution	N/A	MA Forestry Association, P.O. Box 1096, Belchertown, MA 01007. 413/323-7326.	Promote the cultivation of forest resources on private and municipal lands as an activity that provides environmental benefits to the owner and society; increase public appreciation and understanding of good forestry.	Membership organization providing: publications, workshops, seminars, activities, discounts, field days, networking with other farmers; reduction in income, estate, property taxes in conjunction with Chapters 61, 61A or donations to Massachusetts Forestry Association.

Massachusetts Environmental Trust	Massachusetts Environmental Trust/Unrestricted Direct Grant	State Government, Interstate agency, Regional planning agency, Local government, Private landowner, Conservation district, Non-profit organization,	$500K FY98.	Massachusetts Environmental Trust, 33 Union St., 4th Floor, Boston, MA 02108. 617/727-0249.	Encourage direct citizen and community action to restore, protect and enhance natural resources with emphasis on water quality; increase understanding, appreciation and commitment of natural resources through public education, advocacy and research.	Funds directed towards an issue of critical environmental concern.
Massachusetts Environmental Trust	Massachusetts Environmental Trust/Unrestricted General Grant	Conservation district,	$200K FY98; grants range $5K-25K.	Massachusetts Environmental Trust, 33 Union St., 4th Floor, Boston, MA 02108. 617/727-0249.	Encourage direct citizen and community action to restore, protect and enhance natural resources with emphasis on water quality; increase understanding, appreciation and commitment of natural resources through public education, advocacy and research.	Grassroots funding to support local environmental action, public education and citizen involvement.
MDC	Metropolitan District Commission/Parks and Reservations	Local government, Non-profit organization, Educational institution		MDC, Director of Real Property or Director of Planning, 20 Somerset St., Boston, MA 02108. 617/727-5114. Internet at http://www.magnet.state.ma.us/mdc/mdc_home.htm	Protect land as open space in urban areas for use as parks and walking trails.	Land is purchased at fair market value.

MDC, Division of Watershed Management & MDC, Division of Real Property	Metropolitan District Commission/Watershed Protection	Local government, Private landowner, Conservation district, Non-profit organization, Educational institution	$135 million provided for in Watershed Protection Act; $16 million FY98.	Land Acquisition Coordinator, MDC, Division of Watershed Management, 180 Beamon St., West Boylston, MA 01583. 508/835-4816. Internet at http://www.magnet.state.ma.us/mdc/mdc_home.htm	Protect public water supplies of the Commonwealth by preserving lands in watersheds serving MDC controlled reservoirs.	Land purchased at fair market value will be owned and managed by MDC and open for appropriate public use; cost share funds and technical assistance provided to municipalities to develop local plans, by-laws and regulations; easements purchased below fee-simple cost, development prevented but not open to public use.
Migratory Bird Conservation Commission & US FWS	National Wildlife Refuge System (NWR)	State Government, Interstate agency, Regional planning agency, Local government, Private landowner, Conservation district, Non-profit organization, Educational institution	3K new acres added in FY97; LWCF dependant on congressional appropriations; MBCF through Federal Duck Stamp sales etc.	US FWS, Division of Realty, 4401 North Fairfax Dr., Suite 622, Arlington, VA 22203. 703/358-1713. Internet at http://www.refuges.fws.gov	Administer a national network of lands and waters for the conservation, management and where appropriate, restoration of the fish, wildlife and plant resources and their habitats within the nation for the benefit of present and future generations.	Provides funding for the acquisition of land & water resources and/or interests therein, to establish new refuges, waterfowl production areas and coordination areas as well as add to existing ones.
National Fish & Wildlife Foundation	National Fish & Wildlife Foundation Grants	State Government, Interstate agency, Regional planning agency, Local government, Private landowner, Conservation district, Non-profit organization, Private organization, Educational institution	$53 million awarded nationwide for 460 grants FY97.	National Fish & Wildlife Foundation, 1120 Connecticut Ave. NW, Washington, DC 20036. 202/857-0166. Internet at http://www.nfwf.org	The National Fish & Wildlife Foundation is a congressionally established organization that awards Challenge Grants to stimulate private funding and foster cooperative partnerships to conserve fish, wildlife, plants and the habitats on which they depend.	Grants distributed 3 times/year and awarded through 5 initiatives: conservation education, fisheries conservation & management, neotropical migratory bird conservation, wetlands & private lands, wildlife & habitat management.

NRCS & MA DEP, Bureau of Resource Protection, Office of Water Resources	Watershed Protection & Flood Prevention/Small Watershed Program	State Government, Local government, Private landowner, Private organization, Educational institution	$15 million nationwide for planning and $100 million for technical and financial assistance FY98; ave. grant $650K.	Local USDA Service Center, NRCS Field office or State NRCS office at 451 West St., Amherst, MA 01002. 413/253-4351. Internet at http://www.nhq.nrce.usda.gov/OPA/FB960PA/ProgFact.html	Provide planning, technical and financial assistance to local government sponsors to carry out works of improvement to protect, develop and utilize land/water resources in small watersheds.	Cost share grant up to 100% for structural practices and up to 50% for non-structural practices for watershed protection, flood prevention, agriculture water management, recreation and fish & wildlife habitat; loans may be made available for items not covered; NRCS develops work plan and oversees 10 year contract.
NRCS and MA DFA	Farmland Protection Program (FPP)	State Government, Local government, Private landowner,	Up to $35 million nationwide each year through FY2002; $18 million FY98; payment average $387K.	Local USDA Service Center, NRCS Field office or State NRCS office at 451 West St., Amherst, MA 01002. 413/253-4351. Internet at http://www.nrcs.usda.gov/NRCSProg.html	Voluntary program that helps farmers keep their land in agriculture by purchasing conservation easements and other interests to limit non-agricultural use of farmland with prime, unique or other productive soils; this program works in concert with or enhances state/local programs.	USDA provides financial and technical support to state and local government programs to purchase conservation easements and other interests; USDA provides funds up to 50% of fair market value and state/local provide balance; landowner retains ownership while keeping land in agriculture and agreeing not to convert to non-agricultural use; NRCS will also provide technical assistance to facilitate purchase.

NRCS develops Conservation Plans; assistance from FSA, CES and state technical committee	Environmental Quality Incentives Program (EQIP)	Educational institution	$200 million/year nationwide through 2002; 1997 funding: 65% to designated priority areas, 35% to state concerns; 50% of total for livestock operations; ave. grant $30K; estimated $685K for MA FY98.	Local USDA Service Center, NRCS Field office or State NRCS office at 451 West St., Amherst, MA 01002. 413/253-4351. Internet at http://www.nhq.nrcs.usda.gov/OPA/FB960PA/equipfact.html	Voluntary land management conservation program for farmers and ranchers who face threats to soil, water and related natural resources; provides financial, technical and educational assistance primarily in designated Conservation Priority Areas (CPA) to implement structural, vegetative and land management practices.	Provides grant up to 75% of total cost to establish best management practices (BMPs); also provides incentive payments up to 3 years for converting to certain land management practices.
NRCS in cooperation with FSA	Conservation Farm Option	Educational institution	$197.5 million nationwide through 2002; $15 million estimated FY98.	Local USDA Service Center, NRCS Field office or State NRCS office at 451 West St., Amherst, MA 01002. 413/253-4351. Internet at http://www.nrcs.usda.gov/NRCSProg.html	Whole farm management program to integrate conservation activities/practices within active agricultural operations; non-traditional approach to conservation to foster and test innovative conservation technologies and program administration compatible with productive agricultural operations.	Provides cost share funds and annual incentive payments to individual producers who sign 10 year contracts.

NRCS in cooperation with FSA as well as US FWS & MA DFWELE	Wetlands Reserve Program (WRP)	Non-profit organization, Educational institution	$164 million FY98 nationwide; Total enrollment cap of 975K acres by 2002; enrollment cap of 130K acres for FY97.	Local USDA Service Center, NRCS Field office or State NRCS office at 451 West St., Amherst, MA 01002. 413/253-4351. Internet at http://www.nhq.nrce.usda.gov/OPA/FB960PA/WetRule.html	Restore, protect, maintain and manage farmed wetlands, prior converted wetlands, riparian areas and buffer areas on private property; financial incentives to landowners to enhance wetlands in exchange for retiring marginal agricultural land.	On former or degraded wetlands, participant sells conservation easement and/or enters into a cost share agreement to restore/protect wetlands; landowner voluntarily limits future use of land while retaining ownership; NRCS and landowner develop and implement Wetland Restoration Plan designed to restore and maintain the easement area; taxes may be lowered depending upon locality.
NRCS, State Technical Committee administers contract & develops plan.	Wildlife Habitat Incentives Program (WHIP)	Educational institution	$50 million provided until 2002; $30 million nationwide for FY98; $150K for MA FY98.	Local USDA Service Center, NRCS Field office or State NRCS office at 451 West St., Amherst, MA 01002. 413/253-4351. Internet at http://www.nhq.nrce.usda.gov/OPA/FB960PA/ProgFact.html	Land management program to develop, improve and restore wildlife habitat on private property by providing financial incentives to landowners.	Landowner agrees to prepare and implement Wildlife Habitat Development Plan for 5-10 years; NRCS and landowner develop plan; NRCS provides technical and financial assistance up to 75% for initial habitat establishment; landowner must maintain practices; USDA, state wildlife agencies, nonprofit or private organizations may provide more funds for maintenance.

RDA, Rural Utilities Service	Resource Conservation & Development Loans	State Government, Local government, Private landowner,	Operating using funds appropriated prior to FY96.	Local USDA Service Center, Local RDA office or State RDA office at 451 West St., Amherst, MA 01002. 413/253-4300. Internet at http://www.rurdev.usda.gov	Provide loan assistance to local sponsoring agencies in authorized areas to increase economic opportunities for local people through conservation of water & natural resources; finance infrastructure such as water and sewer systems.	Loans provided up to $500K to rural communities.
RDA, Rural Utilities Service	Watershed Protection & Flood Prevention Loans	Local government, Private landowner,	Operating using funds appropriated prior to FY96.	Local USDA Service Center, Local RDA office or State RDA office at 451 West St., Amherst, MA 01002. 413/253-4300. Internet at http://www.rurdev.usda.gov	Provide planning, technical and financial assistance to local government sponsors to carry out works of improvement to protect, develop and utilize land/water resources in small watersheds.	Direct loans available through sponsoring local organizations in authorized watershed areas for watershed works of improvement.
US ACOE & partnership organizations	Aquatic Plant Control	State Government, Local government,	$9.5 million FY96; $0 FY98.	US ACOE, New England District, 424 Trapelo Rd., Waltham, MA 02254-9149. 617/647-8264. Internet at http://www.ned.usace.army.mil	Control and eradicate nuisance aquatic plants in rivers, harbors and allied waters.	Army Corps forms partnerships with state & local governments to control invasive aquatic plants; cost share grant up to 50% of total project cost for plan development and up to 50% for plan implementation.

US ACOE, New England District	Environmental Restoration Program	State Government, Local government, Private landowner, Private organization,	Dependent on congressional appropriations.	US ACOE, New England District, 424 Trapelo Rd., Waltham, MA 02254-9149. 617/647-8552. Internet at http://www.ned.usace.army.mil	Conduct various environmental restoration projects in conjunction with state and local agency goals.	State or local governments apply to Corps directly or through elected representatives for cost sharing of studies of environmental projects. Section 1135: modifications to ACOE structures to improve habitat. Section 906(b): mitigation of habitat impacts during any stage of construction. Section 307: CSO control. Section 219: environmental infrastructure.
US ACOE, New England District	Partners for Environmental Progress (PEP)	Local government, Private landowner,		US ACOE, New England District, 424 Trapelo Rd., Waltham, MA 02254-9149. 617/647-8264. Internet at http://www.ned.usace.army.mil	Provide financial alternatives and analysis for improvements to environmental infrastructure (air, land and water) and to encourage greater private investment in it.	Cost sharing up to 50% with state and local agencies or organizations for environmental studies and financial analysis support.
US BLM; US FWS; USFS; MA EOEA, Division of Conservation Services	Land & Water Conservation Fund (Outdoor Recreation Acquisition)	State Government, Local government,	Currently there is no state funding; funds from the Act go to various federal agency operating budgets ($900 million/yr.) in lieu of adequate appropriations from Congress.	MA EOEA, Division of Conservation Services, 100 Cambridge St., 20th Floor, Room 1405, Boston, MA 02202. 617/727-1552 x292. Internet at http://www.nps.gov/partners.html OR http://www.magnet.state.ma.us/envir/envinfo.htm	Provide funds to acquire, develop and improve public outdoor recreation areas and to acquire land or water habitat for fish & wildlife conservation including endangered species.	Federal side: Federal agencies make requests and Congress appropriates. State side: Federal funds allocated to states; state allocates funds to other state agencies or local governments for specific projects; provides up to 50% of the total project cost;

US EPA, Region 1	Sustainable Development Challenge Grants	State Government, Interstate agency, Regional planning agency, Local government, Private landowner, Conservation district,	$5 million nationwide FY98.	US EPA, Region 1, JFK Federal Building, Boston, MA 02203. 617/565-3551. Internet at http://www.epa.gov/ecocommunity	Promote sustainable development within communities, thereby protecting or improving environmental quality, economic prosperity and social equity.	Seed funds to leverage private & public investment in the form of a cost share grant up to 80% of total project cost (max $200K); 1-3 year project duration.
US FWS	North American Wetlands Conservation Act Grant Program	State Government, Interstate agency, Regional planning agency, Local government, Private landowner, Conservation district, Non-profit organization, Educational institution	$30 million nationwide FY98; grant limit of $1 million.	Grants Program Administrator, North American Waterfowl and Wetlands Office, US FWS, 4401 North Fairfax Dr., Suite 110, Arlington, VA 22203. 703/358-1784. Internet at http://www.fws.gov/r9nawwo/nawcahp.html	Support public and private wetland conservation in order to enhance wetland ecosystems for the waterfowl and wildlife species that depend on them.	Long-term plans of action supported by project grants (cooperative & contract) up to 50% total project cost and matching partner funds; typical contract 2-3 years.
US FWS	North American Wetlands Conservation Act/Small Grants Program	State Government, Interstate agency, Regional planning agency, Local government, Private landowner, Conservation district, Non-profit organization, Educational institution	$500K FY98	Small Grants Coordinator, North American Waterfowl and Wetlands Office, US FWS, 4401 North Fairfax Dr., Suite 110, Arlington, VA 22203. 703/358-1784. Internet at http://www.fws.gov/r9nawwo/nawcahp.html	Promote long term conservation of North American wetland ecosystems and the waterfowl, fish and wildlife that depend upon such habitat. Generate new wetlands partnerships that may translate into larger wetlands conservation initiatives.	Cost share grant providing 50% of total project cost.

US FWS, Conte National Wildlife Refuge	Conte Wildlife Refuge/Challenge Cost Share Program	State Government, Interstate agency, Regional planning agency, Local government, Private landowner, Conservation district, Non-profit organization, Educational institution	$109,075 for 18 projects in FY98.	Challenge Cost Share Program, Silvio O. Conte National Fish and Wildlife Refuge, Great Falls Discovery Center, 38 Avenue A, Turners Falls, MA 01376. 413/863-0209. Internet at http://www.fws.gov/r5soc/index2.html	Encourage partnerships that further the goals of the Conte Refuge Act: land protection outreach, environmental education, habitat restoration and management. Sharing costs of local projects rather than building an extensive land base helps other conservation interests carry out their programs as well.	Grants distributed for approved projects providing up to 50% of total project cost.
US FWS, Conte National Wildlife Refuge	Conte Wildlife Refuge/Partnerships for Wildlife	State Government, Interstate agency, Regional planning agency, Local government, Private landowner, Conservation district, Non-profit organization, Educational institution		Partners for Wildlife Program, Silvio O. Conte National Fish and Wildlife Refuge, Great Falls Discovery Center, 38 Avenue A, Turners Falls, MA 01376. 413/863-0209. Internet at http://www.fws.gov/r5soc/index2.html	Encourage partnerships that further the goals of the Conte Refuge Act: land protection outreach, environmental education, habitat restoration and management. Sharing costs of local projects rather than building an extensive land base helps other conservation interests carry out their programs as well.	Cooperative agreements providing up to 100% of cost to restore or improve wildlife habitat and related environmental education projects.

US FWS, Region V	Partners for Wildlife Habitat Restoration	Local government, Educational institution	$12.6 million nationwide FY98	US FWS, Region V, 300 Westgate Center Drive, Hadley, MA 01035. 413/253-8300. http://www.r6.fws.gov/PFW/index.html	Financial and technical assistance provided to landowners through voluntary cooperative agreements in order to restore wildlife habitat.	Landowner enters a cooperative agreement with the US FWS(at least 10 years) that provides up to 60% of the total project cost; landowner agrees to maintain project & retains full control of his land; balance of cost may be made up by non-profits or municipalities.
US FWS; MA Division of Fisheries & Wildlife; National Fish & Wildlife Foundation	Wildlife Conservation & Appreciation Program	State Government, Local government, Private landowner, Conservation district, Non-profit organization, Educational institution	$768K FY98; average grant $22K.	MA DFWELE, Division of Fisheries & Wildlife, 100 Cambridge St., Rm. 1901, Boston, MA 02202. 617/727-1614 or US FWS, Division of Federal Aid, Arlington Sq., Rm. 140, 4401 N. Fairfax Dr., Arlington, VA 22203. 703/358-2156. Internet at http://www.magnet.stat	Form partnerships in order to carry out wildlife conservation and appreciation projects to preserve & manage a broad array of non-game fish & wildlife species; provide non-consumptive fish & wildlife recreation opportunities.	Cost share agreements (minimum 10 year length) providing up to 30% of cost to restore or improve wildlife habitat.
USDA, Cooperative State Research, Education and Extension Service	Sustainable Agriculture Research & Education	State Government, Local government, Conservation district, Private organization, Educational institution	$7.6 million nationwide FY98.	USDA, Cooperative State Research, Education and Extension Service, Ag. Box, 2201, Washington, DC 20250 or MA CES, Stockbridge Hall, University of Massachusetts, Amherst, MA 01003. 413/545-4800. Internet at http://www.ces.ncsu.edu/san/htdocs/sare	Facilitate research and knowledge of sustainable and environmentally sound practices in agriculture; improve management of on-farm resources; promote alternative agriculture systems.	Individuals and organizations enter cooperative agreements with USDA.

Appendix XI – Nashua River watershed threatened and endangered species

SC = Species of Concern, E = Endangered, T = Threatened, PS = Proposed Species

Town	Taxonomic Group	Scientific name	Common Name	State Rank	Federal Rank	Most Recent Obs
ASHBY	Fish	Notropis bifrenatus	Bridle Shiner	SC		1974
ASHBY	Reptile	Clemmys insculpta	Wood Turtle	SC		1993
ASHBY	Bird	Gavia immer	Common Loon	SC		2000
ASHBY	Dragonfly / Damselfly	Gomphus descriptus	Harpoon Clubtail	E		1940
ASHBY	Dragonfly / Damselfly	Ophiogomphus aspersus	Brook Snaketail	SC		1941
ASHBY	Vascular Plant	Huperzia appalachiana		E		1896
ASHBY	Vascular Plant	Scheuchzeria palustris	Pod-Grass	T		1882
ASHBY	Vascular Plant	Viola adunca	Sand Violet	E		1914
AYER	Fish	Notropis bifrenatus	Bridle Shiner	SC		1928
AYER	Reptile	Clemmys guttata	Spotted Turtle	SC		2000
AYER	Reptile	Clemmys insculpta	Wood Turtle	SC		1992
AYER	Reptile	Emydoidea blandingii	Blanding's Turtle	T		2000
AYER	Reptile	Terrapene carolina	Eastern Box Turtle	SC		1979
AYER	Bird	Bartramia longicauda	Upland Sandpiper	E		1993
AYER	Bird	Ixobrychus exilis	Least Bittern	E		1947
AYER	Vascular Plant	Cyperus houghtonii	Houghton's Flatsedge	E		1991
AYER	Vascular Plant	Liatris borealis	New England Blazing Star	SC		1993
AYER	Vascular Plant	Lygodium palmatum	Climbing Fern	SC		1993
AYER	Vascular Plant	Senna hebecarpa	Wild Senna	E		2000
BOYLSTON	Fish	Notropis bifrenatus	Bridle Shiner	SC		1951
BOYLSTON	Amphibian	Ambystoma opacum	Marbled Salamander	T		1999
BOYLSTON	Reptile	Clemmys guttata	Spotted Turtle	SC		1990
BOYLSTON	Reptile	Clemmys insculpta	Wood Turtle	SC		1983
BOYLSTON	Bird	Gavia immer	Common Loon	SC		2000
BOYLSTON	Bird	Haliaeetus leucocephalus	Bald Eagle	E	(PS)	1999
BOYLSTON	Bird	Podilymbus podiceps	Pied-Billed Grebe	E		1978
BOYLSTON	Vascular Plant	Arceuthobium pusillum	Dwarf Mistletoe	SC		1898
BOYLSTON	Vascular Plant	Hydrophyllum canadense	Broad Waterleaf	E		1943
BOYLSTON	Vascular Plant	Liatris borealis	New England Blazing Star	SC		1932

Town	Taxonomic Group	Scientific name	Common Name	State Rank	Federal Rank	Most Recent Obs
BOYLSTON	Vascular Plant	Ophioglossum pusillum	Adder's-Tongue Fern	T		1996
DUNSTABLE	Fish	Notropis bifrenatus	Bridle Shiner	SC		1988
DUNSTABLE	Amphibian	Ambystoma laterale	Blue-Spotted Salamander	SC		2000
DUNSTABLE	Reptile	Clemmys guttata	Spotted Turtle	SC		1999
DUNSTABLE	Reptile	Clemmys insculpta	Wood Turtle	SC		1989
DUNSTABLE	Reptile	Emydoidea blandingii	Blanding's Turtle	T		2000
DUNSTABLE	Mammal	Synaptomys cooperi	Southern Bog Lemming	SC		1976
DUNSTABLE	Vascular Plant	Calystegia spithamaea	Low Bindweed	E		1928
DUNSTABLE	Vascular Plant	Scheuchzeria palustris	Pod-Grass	T		1928
FITCHBURG	Reptile	Clemmys guttata	Spotted Turtle	SC		1990
FITCHBURG	Reptile	Emydoidea blandingii	Blanding's Turtle	T		1996
FITCHBURG	Mussel	Strophitus undulatus	Squawfoot	SC		1999
FITCHBURG	Vascular Plant	Adlumia fungosa	Climbing Fumitory	T		1879
GROTON	Amphibian	Ambystoma laterale	Blue-Spotted Salamander	SC		2000
GROTON	Amphibian	Hemidactylium scutatum	Four-Toed Salamander	SC		1999
GROTON	Reptile	Clemmys guttata	Spotted Turtle	SC		2000
GROTON	Reptile	Emydoidea blandingii	Blanding's Turtle	T		2000
GROTON	Reptile	Terrapene carolina	Eastern Box Turtle	SC		1999
GROTON	Bird	Botaurus lentiginosus	American Bittern	E		1947
GROTON	Bird	Gavia immer	Common Loon	SC		1915
GROTON	Bird	Podilymbus podiceps	Pied-Billed Grebe	E		1947
GROTON	Bird	Vermivora chrysoptera	Golden-Winged Warbler	E		1947
GROTON	Crustacean	Crangonyx aberrans	Mystic Valley Amphipod	SC		1985
GROTON	Dragonfly / Damselfly	Aeshna mutata	Spatterdock Darner	E		1997
GROTON	Dragonfly / Damselfly	Ophiogomphus aspersus	Brook Snaketail	SC		1999
GROTON	Dragonfly / Damselfly	Stylurus scudderi	Zebra Clubtail	E		1997
GROTON	Butterfly / Moth	Hemileuca maia maia	Coastal Barrens Buckmoth	T		1919
GROTON	Butterfly / Moth	Sphinx luscitiosa	Clemens' Hawkmoth	SC		1972
GROTON	Vascular Plant	Amelanchier sanguinea	Roundleaf Shadbush	SC		1905
GROTON	Vascular Plant	Calystegia spithamaea	Low Bindweed	E		1999
GROTON	Vascular Plant	Lygodium palmatum	Climbing Fern	SC		2000
GROTON	Vascular Plant	Sparganium natans	Small Bur-Reed	E		1996

Town	Taxonomic Group	Scientific name	Common Name	State Rank	Federal Rank	Most Recent Obs
HARVARD						
HARVARD	Fish	Notropis bifrenatus	Bridle Shiner	SC		1928
HARVARD	Amphibian	Ambystoma laterale	Blue-Spotted Salamander	SC		1999
HARVARD	Amphibian	Hemidactylium scutatum	Four-Toed Salamander	SC		1970
HARVARD	Reptile	Clemmys guttata	Spotted Turtle	SC		1931
HARVARD	Reptile	Clemmys insculpta	Wood Turtle	SC		1995
HARVARD	Reptile	Emydoidea blandingii	Blanding's Turtle	T		1999
HARVARD	Reptile	Terrapene carolina	Eastern Box Turtle	SC		1980
HARVARD	Bird	Accipiter striatus	Sharp-Shinned Hawk	SC	(PS)	1911
HARVARD	Bird	Ammodramus savannarum	Grasshopper Sparrow	T	(PS)	1994
HARVARD	Bird	Botaurus lentiginosus	American Bittern	E		1992
HARVARD	Bird	Podilymbus podiceps	Pied-Billed Grebe	E		1984
HARVARD	Mussel	Alasmidonta undulata	Triangle Floater	SC		1997
HARVARD	Crustacean	Crangonyx aberrans	Mystic Valley Amphipod	SC		1978
HARVARD	Beetle	Desmocerus palliatus	Elderberry Long-Horned Beetle	SC		1998
HARVARD	Vascular Plant	Alnus viridis ssp crispa	Mountain Alder	SC		1932
HARVARD	Vascular Plant	Amelanchier sanguinea	Roundleaf Shadbush	SC		1947
HARVARD	Vascular Plant	Carex typhina	Cat-Tail Sedge	T		1999
HARVARD	Vascular Plant	Eleocharis obtusa var ovata	Ovate Spike-Sedge	E		1991
HARVARD	Vascular Plant	Lygodium palmatum	Climbing Fern	SC		1999
HARVARD	Vascular Plant	Ophioglossum pusillum	Adder's-Tongue Fern	T		1940
HARVARD	Vascular Plant	Prenanthes serpentaria	Lion's Foot	E		1901
HARVARD	Vascular Plant	Sparganium natans	Small Bur-Reed	E		1994
HARVARD	Vascular Plant	Veronicastrum virginicum	Culver's-Root	SC		1993
HOLDEN	Amphibian	Gyrinophilus porphyriticus	Spring Salamander	SC		1994
HOLDEN	Reptile	Clemmys guttata	Spotted Turtle	SC		1997
HOLDEN	Reptile	Clemmys insculpta	Wood Turtle	SC		1999
HOLDEN	Reptile	Emydoidea blandingii	Blanding's Turtle	T		1999
HOLDEN	Dragonfly / Damselfly	Enallagma carunculatum	Tule Bluet	SC		
HOLDEN	Beetle	Desmocerus palliatus	Elderberry Long-Horned Beetle	SC		1901
HOLDEN	Vascular Plant	Arceuthobium pusillum	Dwarf Mistletoe	SC		1985
HOLDEN	Vascular Plant	Scheuchzeria palustris	Pod-Grass	T		1917

Town	Taxonomic Group	Scientific name	Common Name	State Rank	Federal Rank	Most Recent Obs
LANCASTER	Amphibian	Ambystoma laterale	Blue-Spotted Salamander	SC		1997
LANCASTER	Reptile	Clemmys guttata	Spotted Turtle	SC		2000
LANCASTER	Reptile	Clemmys insculpta	Wood Turtle	SC		1998
LANCASTER	Reptile	Emydoidea blandingii	Blanding's Turtle	T		1996
LANCASTER	Reptile	Terrapene carolina	Eastern Box Turtle	SC		1992
LANCASTER	Bird	Accipiter striatus	Sharp-Shinned Hawk	SC	(PS)	1909
LANCASTER	Bird	Ammodramus henslowii	Henslow's Sparrow	E		1939
LANCASTER	Bird	Ammodramus savannarum	Grasshopper Sparrow	T	(PS)	1988
LANCASTER	Bird	Asio otus	Long-Eared Owl	SC		1898
LANCASTER	Bird	Bartramia longicauda	Upland Sandpiper	E		1994
LANCASTER	Bird	Circus cyaneus	Northern Harrier	T		1904
LANCASTER	Bird	Rallus elegans	King Rail	T		1999
LANCASTER	Mammal	Sorex palustris	Water Shrew	SC		1986
LANCASTER	Mussel	Alasmidonta undulata	Triangle Floater	SC		1997
LANCASTER	Dragonfly / Damselfly	Enallagma laterale	New England Bluet	SC		1939
LANCASTER	Beetle	Desmocerus palliatus	Elderberry Long-Horned Beetle	SC		1997
LANCASTER	Butterfly / Moth	Apharetra dentata	Blueberry Sallow	SC		1994
LANCASTER	Butterfly / Moth	Itame sp 1	Pine Barrens Itame	SC		1992
LANCASTER	Butterfly / Moth	Zanclognatha martha	Pine Barrens Zanclognatha	T		1994
LANCASTER	Vascular Plant	Amelanchier sanguinea	Roundleaf Shadbush	SC		1947
LANCASTER	Vascular Plant	Arceuthobium pusillum	Dwarf Mistletoe	SC		1924
LANCASTER	Vascular Plant	Carex typhina	Cat-Tail Sedge	T		1996
LANCASTER	Vascular Plant	Cyperus houghtonii	Houghton's Flatsedge	E		1991
LANCASTER	Vascular Plant	Eleocharis obtusa var ovata	Ovate Spike-Sedge	E		1991
LANCASTER	Vascular Plant	Eragrostis frankii	Frank's Lovegrass	SC		1939
LANCASTER	Vascular Plant	Liatris borealis	New England Blazing Star	SC		1908
LANCASTER	Vascular Plant	Panicum philadelphicum	Philadelphia Panic-Grass	SC		1995
LANCASTER	Vascular Plant	Petasites frigidus var palmatus	Sweet Coltsfoot	T		1912
LANCASTER	Vascular Plant	Platanthera dilatata	Leafy White Orchis	T		1904
LANCASTER	Vascular Plant	Platanthera flava var herbiola	Pale Green Orchis	T		1944

Town	Taxonomic Group	Scientific name	Common Name	State Rank	Federal Rank	Most Recent Obs
LEOMINSTER	Amphibian	Ambystoma laterale	Blue-Spotted Salamander	SC		1998
LEOMINSTER	Reptile	Clemmys guttata	Spotted Turtle	SC		2000
LEOMINSTER	Reptile	Clemmys insculpta	Wood Turtle	SC		2000
LEOMINSTER	Bird	Gavia immer	Common Loon	SC		2000
LEOMINSTER	Crustacean	Eubranchipus intricatus	Intricate Fairy Shrimp	SC		1998
LEOMINSTER	Dragonfly/Damselfly	Ophiogomphus aspersus	Brook Snaketail	SC		1940
LEOMINSTER	Vascular Plant	Arceuthobium pusillum	Dwarf Mistletoe	SC		1924
LEOMINSTER	Vascular Plant	Malaxis bayardii	Bayard's Green Adder's-Mouth	E		1999
LEOMINSTER	Vascular Plant	Panicum philadelphicum	Philadelphia Panic-Grass	SC		1949
LUNENBURG	Amphibian	Gyrinophilus porphyriticus	Spring Salamander	SC		1969
LUNENBURG	Reptile	Clemmys guttata	Spotted Turtle	SC		1996
LUNENBURG	Reptile	Emydoidea blandingii	Blanding's Turtle	T		1995
LUNENBURG	Bird	Accipiter striatus	Sharp-Shinned Hawk	SC	(PS)	1937
LUNENBURG	Bird	Bartramia longicauda	Upland Sandpiper	E		1892
LUNENBURG	Bird	Botaurus lentiginosus	American Bittern	E		1990
LUNENBURG	Bird	Cistothorus platensis	Sedge Wren	E		1937
LUNENBURG	Mammal	Sorex palustris	Water Shrew	SC		1914
LUNENBURG	Mammal	Synaptomys cooperi	Southern Bog Lemming	SC		1898
LUNENBURG	Beetle	Desmocerus palliatus	Elderberry Long-Horned Beetle	SC		1996
LUNENBURG	Vascular Plant	Platanthera flava var herbiola	Pale Green Orchis	T		1938
PEPPERELL	Amphibian	Ambystoma opacum	Marbled Salamander	T		1999
PEPPERELL	Reptile	Clemmys guttata	Spotted Turtle	SC		1999
PEPPERELL	Reptile	Clemmys insculpta	Wood Turtle	SC		1997
PEPPERELL	Reptile	Emydoidea blandingii	Blanding's Turtle	T		1999
PEPPERELL	Bird	Ammodramus savannarum	Grasshopper Sparrow	T	(PS)	1978
PEPPERELL	Mussel	Alasmidonta undulata	Triangle Floater	SC		1996
PEPPERELL	Mussel	Alasmidonta varicosa	Brook Floater (Swollen Wedgemussel)	E		1996
PEPPERELL	Dragonfly/Damselfly	Aeshna mutata	Spatterdock Darner	E		1997
PRINCETON	Fish	Notropis bifrenatus	Bridle Shiner	SC		1960
PRINCETON	Amphibian	Ambystoma opacum	Marbled Salamander	T		2000

Town	Taxonomic Group	Scientific name	Common Name	State Rank	Federal Rank	Most Recent Obs
PRINCETON	Amphibian	Gyrinophilus porphyriticus	Spring Salamander	SC		1968
PRINCETON	Amphibian	Hemidactylium scutatum	Four-Toed Salamander	SC		1999
PRINCETON	Reptile	Clemmys guttata	Spotted Turtle	SC		1999
PRINCETON	Reptile	Clemmys insculpta	Wood Turtle	SC		2000
PRINCETON	Reptile	Emydoidea blandingii	Blanding's Turtle	T		1993
PRINCETON	Bird	Ammodramus henslowii	Henslow's Sparrow	E		1945
PRINCETON	Bird	Bartramia longicauda	Upland Sandpiper	E		
PRINCETON	Bird	Cistothorus platensis	Sedge Wren	E		1942
PRINCETON	Mammal	Sorex palustris	Water Shrew	SC		1990
PRINCETON	Beetle	Desmocerus palliatus	Elderberry Long-Horned Beetle	SC		1914
PRINCETON	Butterfly / Moth	Cingilia catenaria	Chain Dot Geometer	SC		1927
PRINCETON	Vascular Plant	Amelanchier bartramiana	Bartram's Shadbush	T		1983
PRINCETON	Vascular Plant	Carex backii	Back's Sedge	E		1997
PRINCETON	Vascular Plant	Ophioglossum pusillum	Adder's-Tongue Fern	T		1894
PRINCETON	Vascular Plant	Rhododendron maximum	Great Laurel	T		1999
PRINCETON	Vascular Plant	Senna hebecarpa	Wild Senna	E		1879
PRINCETON	Vascular Plant	Trisetum triflorum ssp molle	Spiked False Oats	E		1878
PRINCETON	Vascular Plant	Vaccinium vitis-idaea ssp minus	Mountain Cranberry	E		186-
SHIRLEY	Fish	Notropis bifrenatus	Bridle Shiner	SC		1954
SHIRLEY	Amphibian	Ambystoma laterale	Blue-Spotted Salamander	SC		1999
SHIRLEY	Amphibian	Hemidactylium scutatum	Four-Toed Salamander	SC		1989
SHIRLEY	Reptile	Clemmys guttata	Spotted Turtle	SC		2000
SHIRLEY	Reptile	Clemmys insculpta	Wood Turtle	SC		1997
SHIRLEY	Reptile	Emydoidea blandingii	Blanding's Turtle	T		1999
SHIRLEY	Dragonfly / Damselfly	Ophiogomphus aspersus	Brook Snaketail	SC		1939
SHIRLEY	Dragonfly / Damselfly	Somatochlora kennedyi	Kennedy's Emerald	E		1939
SHIRLEY	Vascular Plant	Asclepias purpurascens	Purple Milkweed	T		1916
SHIRLEY	Vascular Plant	Lygodium palmatum	Climbing Fern	SC		1911
SHIRLEY	Vascular Plant	Senna hebecarpa	Wild Senna	E		1882
STERLING	Reptile	Clemmys guttata	Spotted Turtle	SC		2000
STERLING	Reptile	Clemmys insculpta	Wood Turtle	SC		2000
STERLING	Bird	Botaurus lentiginosus	American Bittern	E		1992

Town	Taxonomic Group	Scientific name	Common Name	State Rank	Federal Rank	Most Recent Obs
STERLING	Bird	Gavia immer	Common Loon	SC		2000
STERLING	Bird	Haliaeetus leucocephalus	Bald Eagle	E	(PS)	1976
STERLING	Bird	Podilymbus podiceps	Pied-Billed Grebe	E		1954
STERLING	Mussel	Alasmidonta undulata	Triangle Floater	SC		1997
STERLING	Vascular Plant	Amelanchier sanguinea	Roundleaf Shadbush	SC		1940
STERLING	Vascular Plant	Platanthera flava var herbiola	Pale Green Orchis	T		
TOWNSEND	Fish	Notropis bifrenatus	Bridle Shiner	SC		1996
TOWNSEND	Reptile	Clemmys guttata	Spotted Turtle	SC		1999
TOWNSEND	Reptile	Clemmys insculpta	Wood Turtle	SC		1994
TOWNSEND	Reptile	Emydoidea blandingii	Blanding's Turtle	T		2000
TOWNSEND	Bird	Botaurus lentiginosus	American Bittern	E		1987
TOWNSEND	Mussel	Alasmidonta undulata	Triangle Floater	SC		1997
TOWNSEND	Mussel	Strophitus undulatus	Squawfoot	SC		1997
TOWNSEND	Dragonfly / Damselfly	Enallagma laterale	New England Bluet	SC		1967
TOWNSEND	Dragonfly / Damselfly	Ophiogomphus aspersus	Brook Snaketail	SC		1997
WEST BOYLSTON	Reptile	Clemmys guttata	Spotted Turtle	SC		1998
WEST BOYLSTON	Reptile	Clemmys insculpta	Wood Turtle	SC		1997
WEST BOYLSTON	Bird	Haliaeetus leucocephalus	Bald Eagle	E	(PS)	1999
WEST BOYLSTON	Vascular Plant	Arceuthobium pusillum	Dwarf Mistletoe	SC		1899
WEST BOYLSTON	Vascular Plant	Ophioglossum pusillum	Adder's-Tongue Fern	T		1932
WESTMINSTER	Amphibian	Gyrinophilus porphyriticus	Spring Salamander	SC		1999
WESTMINSTER	Amphibian	Hemidactylium scutatum	Four-Toed Salamander	SC		1962
WESTMINSTER	Reptile	Clemmys guttata	Spotted Turtle	SC		1994
WESTMINSTER	Reptile	Clemmys insculpta	Wood Turtle	SC		1999
WESTMINSTER	Bird	Accipiter striatus	Sharp-Shinned Hawk	SC	(PS)	1987
WESTMINSTER	Bird	Botaurus lentiginosus	American Bittern	E		1989
WESTMINSTER	Mussel	Strophitus undulatus	Squawfoot	SC		1999

Appendix XII - Example data collection forms for assessments/inventories

The following forms have been included for use in this section of the document:

Adopt-A-Stream Riparian Area Survey Form

Adopt-A-Stream Riverways Community Report Card

Adopt-A-Stream Shoreline Survey

Bioregional Quiz

Bird Count Point Form

Delaware River Basin Commission Water Snapshot Form

GROWetlands Project Sponsor Form

GROWetlands Wetlands Restoration Project Nomination Form

Massachusetts Audubon Extension Service Forest Inventory Form

Massachusetts Audubon Extension Service Vegetation Inventory Form

Massachusetts Natural Heritage and Endangered Species Program (MNHESP) Community Field Form and Instructions

MNHESP Rare Animal Observation Form

MNHESP Rare Plant Observation Form

MNHESP Vernal Pool Certification Form

MNHESP Vernal Pool Observation Form

University of Massachusetts Extension Habitat Checklist and Instructions

University of Massachusetts Extension Wildlife Habitat Evaluation Summary Sheet

United States Department of Agriculture Natural Resources Conservation Service Stream Visual Assessment Protocol Form and Instructions

MASSACHUSETTS ADOPT-A-STREAM PROGRAM
RIPARIAN AREA SURVEY

INTRODUCTION

The Riparian Area Survey is a follow up for Stream Teams, Conservation Commissions, Watershed Associations or Watershed Teams who have identified areas that would benefit from a riparian restoration project. This survey examines the land use adjacent to the stream and looks at the functions of this area.

Rivers and streams are dynamic and changing. Erosion of a stream bank can be a natural part of the process, or it can be exacerbated by lack of vegetation. Re-vegetation can be very effective on small and medium sized streams where loss of vegetation has its greatest impact. Placing native vegetation on eroded stream banks can stabilize the soil and stream bank and provide habitat for wildlife. The intent of the survey is to find areas that can not only benefit from vegetative – native species – restoration but are suitable for a volunteer project.

Things to consider as you choose preliminary sites. (1) Volunteers must have a site where they can work safely. Avoid sites where the flow of the stream or the steepness of the site could provide danger. (2) Projects must be relatively simple. Avoid choosing sites that would threaten structures, bridge abutments, foundations or sewer pipes, or areas that require regrading and/or heavy machinery. When in doubt get technical help and consult the local Conservation Commission.

The Riparian Area Survey includes four steps leading to implementation

1. Background Work
   a. Shoreline Survey
   b. Preliminary choice of areas to survey
   c. Evaluation of type of natural landscape
   d. Orientation using USGS topographic maps and aerial maps
2. Field Work: Inventory Data Sheets
   a. Riparian Area Inventory describes the physical nature of the riparian corridor, land use, wildlife use and impacts.
3. Assessment Sheets and Riparian Action Matrix
   a. The Assessment Sheets help to rank areas based on characteristics and impacts.
   b. The Riparian Action Matrix takes into account several other criteria such as management objectives, feasibility, and funding sources.
4. Action Plan - includes tasks and steps resulting in implementation of the riparian restoration.

RIPARIAN AREA INVENTORY SHEETS

As part of your background work, you will use topographic maps to determine the length of your survey areas. Once you have determined the area, conduct a preliminary reconnaissance to determine potential problems with access and safety issues. In general, by defining the minimum length of your area to be between 100 and 1000 feet, the data collector can obtain information in a reasonable amount of time and still be accurate. Other guidelines for section length could be continuous land use type, the area of similar vegetated widths, and changes in stream width.

Riparian Area Inventory: The purpose of the inventory is primarily to gather data about the site. The Riparian Area Inventory looks at two zones and the land uses within 500 feet of the stream. **Zone 1** is the stream-side zone or plant community adjacent to the stream beginning at the top of the stream bank and extending to 15 feet. **Zone 2** is the area beginning at the edge of Zone 1 and varies in width. Land use beyond Zone 2 and within 500 feet of the stream will also be identified. The major historical plant community associated with riparian areas is usually a mature forest, although on certain sites, the historic plant community might be shrubs or grass.

Zone 1 begins at the top of the stream bank and occupies a strip of land with a fixed width of fifteen (15) feet measured horizontally on a line perpendicular to the streambank. You are asked to describe physical characteristics as well as vegetation in this zone. This zone has the potential to be important habitat, to filter pollutants, to provide shading for temperature control, to prevent erosion, and to contribute necessary large woody debris to the stream ecosystem. For the most benefit to the stream this section should be in trees or shrubs. If clear cut and inappropriately used, it has the potential to be a barrier to wildlife, to bring nonpoint source pollution runoff into the stream, to raise temperatures, and to encourage erosion and sedimentation. Vegetation in this zone should not be disturbed, and where absent should be reestablished. Vegetation on the east and south bank provide the most shade.

Zone 2 begins at the edge of Zone 1 and occupies an additional strip of land with a minimum width of eighty five (85) feet measured horizontally in the direction of flow. Total minimum widths of Zone 1 and 2 is therefore 100 feet. Your definition of Zone 2 may be increased to create a greater combined width for Zone 1 and Zone 2. For purposes of the Massachusetts Wetlands Protection Act, 200 feet constitutes the riparian area. The width you choose for Zone 2 depends on the functions of the riparian area, including buffering pollutants and providing habitat. Your choice will vary depending on stream order, extent of the 100 year floodplain, adjacent steep slopes or wetland areas. This width will provide wildlife habitat, including travel corridors and cover, as well as a filtering area for nutrients and other pollutants. This zone should also be in trees and shrubs for the maximum benefit to the stream. In forested areas the NRCS encourages periodic harvesting of vegetation to maintain vigorous growth and leaf litter replacement and to remove nutrients and pollutants. Shade levels and production of leaf litter, detritus and large woody debris still must be maintained.

Land Use Up to 500 feet

The purpose of this portion of the survey is to characterize land use in the impacting area adjacent to riparian areas. Information from this question will help you choose what your management goal is for this segment**.** Inventorying the land use within 500 feet of the stream is also important because it provides information about the type or condition of the water flowing into the riparian area. This will have an impact on the target width of Zone 2. In many places this area will be developed and you will want to determine how flow is getting through to Zone 2. This information will also assist in identifying areas that need preservation, enhancement or restoration.

For example, if the land use within 500 feet of the stream is a mowed residential lawn up to the stream bank, Zone 2 could be enhanced with vegetation and increased in width depending on the landowner's objectives. At this site enhancement may be the management goal. On the other hand, if the land use within 500 feet is primarily paved with a bit of grass in Zone 1, restoration of Zone 1 and 2 may be your management goal.

Riparian Area Inventory

Name ________________________________ Date_______ Time ______
Segment Length _____________(min 100'), (max 1000')
Weather conditions today____
Weather Past 3-5 days ____

Stream Side Zone 1 - ≥ 15 ft

Describe:
Width of Zone 1 ________ft. Stream Width ___________ft.
Average Slope of Zone 1 ______% Av. Tree Height __________ft.
Aspect (E,W,N,S)______

Check Most Abundant Land Cover Types:

☐ Constructed Steam Bank ☐ Natural Stream Bank ☐ eroding soil
☐ vertical wall ☐ grass ☐ Bare soil
☐ constructed slope ☐ brush ☐ Slumping Bank
☐ trees ☐ Gully Entering Stream

Plant Information:
Trees present: Yes ☐ No ☐
Spacing between trees and shrubs: ☐ 0 -10 ft ☐ 10-20 feet ☐ > 20 ft
Some trees hanging over or in stream: ☐ Yes ☐ No
Density of grass: ☐ Thick (bare soil on < 10%) ☐ adequate
☐ sparse (bare soil < 25% surface)

Types of plants:
trees____
____
shrubs____
____
grasses/flowers____
____

Shading
☐ well shaded 100-80% ☐ moderately shaded 80-50%
☐ some shade 50-25% ☐ <25%

Describe General Condition:

Riparian Area Inventory

Name ____________________________Segment _______ Page 2

Stream Side Zone 2

Describe:

Width of Zone 2 _________ft.

Average Slope of Zone 2 ______% Av. Tree Height ___________ft.

Check Most Abundant Land Cover Types:

☐ bare soil__________%

☐ paved ☐ grass--- ☐ mowed ☐ unmowed

☐ gravel or compacted soil ☐ shrubs-- ☐ continuous cover ☐ scattered

☐ Buildings ☐ trees-- ☐ continuous cover ☐ scattered

Plant Information:

Trees present: Yes ☐ No ☐

Spacing between trees and shrubs: ☐ 0 -10 ft ☐ 10-20 feet ☐ > 20 ft

Density of grass: ☐ Thick (bare soil on < 10%) ☐ adequate

☐ sparse (bare soil < 25% surface)

Types of plants:

trees____

____

shrubs____

____

grasses/flowers____

____

Shading

☐ well shaded 100-80% ☐ moderately shaded 80-50%

☐ some shade 50-25% ☐ <25%

Describe General Condition and Land Use:

Riparian Area Inventory

Name ____________________________Segment _______ Page 3

Land Use and Habitat

What are the land uses visible from the river? (*checkmark and circle the dominant land use type*.)

___ Industrial
___ Commercial
___ Agricultural
___ Residential
___ Park/ ballfields
___ Parking lots
___ Roads
___ Landfills
___ Railroads
___ Junkyards
___ Golf courses
___ Protected/conservation land
___ Undeveloped/unprotected land
___ Wastewater treatment plants

Agricultural use:

☐ abandoned, no mowing ☐ abandoned, periodic mowing ☐ Tilled soil

☐ pasture ☐ contour farming ☐ strip crops ☐ grassed buffer

☐ Evidence of erosion from any sources reaching the stream

Describe erosion ____

Commercial/Industrial:

☐ Raised beds with curbing ☐ raised beds, no curbs ☐ paved, good cond.

☐ bare ground or stones ☐ paved, poor cond. ☐ grass, managed

☐ wild, unmanaged

Forest land use

☐ No evidence of recent harvest ☐ Recent harvest (<5 yrs) stumps present

☐ Currently being harvested

☐ 100% removal of trees ☐ 50 -99% removal ☐ less than 50% removal

☐ Evidence of erosion from any sources reaching the stream _____________

☐ Evidence of historic plant community. Describe____________________

Riparian Area Inventory

Name ____________________________Segment _______ Page 4

Residential use ☐ evidence of people accessing the water body ☐ no access
(for private residences or housing complexes)
☐ Paths to the water ☐ Other signs of private use__________________________

Urban/rural Land Use ☐ Lawns ☐ Natural area ☐ Garden area
☐ Playground ☐ Buildings ☐ Other _____________
☐ Erosion (describe) ____

Storm Water
☐ storm water pipes present #_____________ ☐Flowing ☐ Not Flowing
☐ ditches present #______________________ ☐Flowing ☐ Not Flowing
Distance from outlet of pipe or ditch to the stream or brook _____________ft.
Describe water in pipe or ditch:____
____
Is there sediment being deposited in the stream at the outlet of the pipe or ditch?
____

☐ Catch basins or drains present # _______ Are they: ☐Clean ☐ Debris

☐ Overland flow through vegetation ☐ Overland flow with pavement and curbs

Wildlife/Habitat

Wildlife use:
Do you see fish or evidence of fish?
(describe)____
Estimate number ______________. *If possible, describe species & size.*__________
Evidence of fish? (i.e. nests) __________________________________

Other forms of aquatic life? *(circle, identify species if known)*
Aquatic insects Turtles Frogs Salamander Snail Mussel Clams
Other_________________________
Evidence of aquatic species? (i.e. eggs, tracks) _________________________

Animals or evidence of animals? *(circle)*
Holes Teeth marks Food storage/eating Dens Scat
Footprints/tracks
Specific animals seen (or evidence of) ____________________________________

Riparian Area Inventory

Name ______________________________Segment _______ Page 5

Wildlife habitat
Plants with berries, nuts or cones present ☐ or possible ☐

"Edge" of large trees, shrubs and unmowed vegetation present ☐

Are there threatened or endangered plants ☐ animals ☐

Wildlife and fish habitat elements present in water *(check)*

__Pools and riffles in stream

__Gravel stream bottom

__Rocks and boulders in stream

__Emergent aquatic vegetation

__Vegetation hanging over the banks and water

__Fallen trees in water

Wildlife habitat elements located near the stream *(check)*

__Standing dead trees

__Fallen tree limbs and trunks

__Scattered rocks and boulders

__Stone walls (without cement)

__Vines

__Springs and seeps

__Vernal pools

Connectivity
Riparian area segment is continuous over 2 or more stream segments both up and down stream ☐

Riparian area segment connects across stream to buffer on opposite side ☐

Riparian Buffer Assessment Worksheet Guide

The Assessment takes the information gathered in the Inventory Sheets and gives you the ability to determine which section of the riparian area has the greatest potential for restoration, enhancement or preservation. A low score represents a need for restoration, while a high score may indicate a good area for preservation. A more specific and technical assessment can be accomplished with the Stream Visual Assessment Protocol (SVAP) developed by NRCS.

Before Using:

1. Locate an ideal riparian site and evaluate.
2. Adjust the points based on the priority concerns. If large woody debris is the concern, adjust point value to reflect this function importance.
3. Ground test the ranking procedure with an excellent, moderate and poor site and adjust ranking points to meet desired results.

By locating an "ideal" riparian buffer site on your stream, you will be able to compare what your site looks like with a healthy buffer system. The "ideal" buffer site will depend on the broader ecosystem that you are trying to protect or enhance. In a forested ecosystem, you would look for an area with a good canopy and shade, leaf litter and an understory. It may not be practical or desired to exactly recreate the "ideal" buffer at the site in question, but it provides a basis for comparison. It is important to identify the habitat elements present in a healthy buffer that are important for that particular ecosystem as well as the aspects of the buffer that serve to remediate pollution. You should try to enhance or restore as many habitat elements from the native ecosystem as practical.

Forest Cover – Riparian forest areas used as buffers provide the best vegetative cover for multiple benefits. Mixed forests of various species are much better than single species forest. Grasses that are unmowed or mowed only yearly are the next best land cover. A mixture of thick grass, shrubs and mature trees are an ideal buffer system.

Management – A forest used as a buffer that is old and unmanaged provides excellent habitat. For purposes of nutrient management, periodic removal of trees/grasses result in nutrient export from the site and allow for vigorous growth. Over harvesting, removal of enough trees to allow complete sun light to reach the surface over a large surface, removes too many trees that could be absorbing nutrients. Likewise the removal of trees from the stream edge removes or prevents the potential for large woody debris from entering the stream system.

Water Flow – Any time a riparian area is compromised by the presence of a direct flow ditch, stream, or pipe, the area fails to complete its function as a buffer. The situation is greatly worsened by any erosion that may be associated with the ditch, stream or pipe. Riparian areas are also influenced greatly by water flow from different types of up-slope land uses. For example, impervious surfaces may concentrate flow; whereas agricultural fields or lawns may spread flow out or filter flow prior to entering the area.

Location – Vegetation on particular sides of the stream are of greater importance in respect to shading.

Height – The larger and taller the vegetation is in respect to the stream, the greater the value in providing shading, and stream detritus.

Woody Debris and Length – The presence of woody debris greatly enhances fish habitat values. Wildlife and recreational functions are enhanced by long continuous lengths of riparian areas on both sides of the stream.

Riparian Buffer Assessment Worksheet

Name ___________________________ **Segment___________________**

Highest Value: Area with a 35 foot uncut stream zone and a managed, healthy vigorous forest for 65 feet with no soil disturbance up-slope from the forested zone. Buffer has large and tall trees nearest the bank. Trees are as tall as the stream is wide and some overhang. TALLY THE POINTS.

Forest Cover (70 points maximum)

1. How wide is the buffer? (Zone 1 and Zone 2 combined)

   Add **10 points** for every 20 feet of trees growing within 100 feet of the stream. ____

   Add **5 points** for every 20 feet of shrubs or thick uncut grass (no trees) within 100 feet of the stream. + ____

2. What is the composition of the buffer?

   Add **10 points** for a mixed softwood and hardwood stand. + ____

   Add **10 points** for a dense (>80% cover) understory of shrubs or saplings. + ____

Effectiveness of Forest Cover

1. Add **10 points** if the spacing between the trees is 0-10 ft or the trees provide continuous cover. (cover/management) + ____

2. How much shade does the buffer provide to the stream?

   Add **10 points** if the buffer is located to the east or south of the stream. (aspect) + ____

3. How high is the buffer?

a. The buffer tree height is ½ the stream width.

b. The buffer tree height is as tall as the stream is wide.

   (add **5 points** for (a), and **10 points** for (b)) + ____

Overland Flow

1. What is the major up-slope land cover?

a. The major up-slope land cover is trees.

b. The major up-slope land cover is thick unmowed grass/shrubs.

c. The major up-slope land cover is agricultural crops/mowed grass (lawns).

d. The major up-slope land cover is pavement

(add **10 points** for (a), **5 points** for (b), **2 points** for (c), and **0 points** for (d)) + ____

2. Add **10 points** if there are no signs of surface flow (gullies, swales) or subsurface pipes entering the stream. +_____

Woody Debris (Habitat) and Length

1. Add **10 points** if some trees are hanging over the stream or have fallen in the stream. + ____

2. Add **10 points** if the buffer is continuous over 2 or more stream segment lengths up and down stream. + ____

TOTAL ________

RIVERWAYS COMMUNITY REPORT CARD

RATING YOUR COMMUNITY'S EFFORTS IN RIVER PROTECTION:

Riverways has designed this report card to help local officials and river advocates determine how much more work their communities need to do to protect their rivers. Towns have the responsibility and the authority for land use planning through bylaws, regulations and zoning. If towns do not do this planning, resources will be lost, and the town character may be changed. Regulation is a low/no cost method of protection. Towns are familiar with many zoning and regulatory techniques, but many towns have not as yet utilized them for rivers. River protection is in its infancy in Massachusetts. We need to work quickly to protect and restore our rivers for the future. A "plan" answer receives one point, and a "no" answer receives no points.

The questions are divided into two segments. The first looks at protecting the land adjacent to the river and the tools for protection. The second segment looks at protecting the river's water quantity and quality by various methods.

Generally, the questions have three choices: "yes", "plan", and "no". A "yes" answer receives two points. A "plan" answer indicates that your community has actually begun the planning for the bylaw or regulation, but has not yet approved the final version.

Few towns will receive "excellent" or even "good" scores. The purpose of the report card is to determine what needs to be done.

We recommend that watershed associations work with their member towns to complete the report card so that both the association and the towns will know the extent of the protection throughout their watershed. By sharing knowledge, cities and towns will support each others efforts and more will be done to protect the rivers. At the end of the data collection, a composite could be made. This composite should be shared with the local towns as a means for action and should be shared with the Regional Planning Agency for its information gathering. Riverways would appreciate a copy for its file.

SCORING:
A "yes" answer receives two points; a "plan" answer receives one point, and a "no" answer receives no points. (A "plan" answer means concrete plans are in the works; it does not mean good intentions.)

Protection for Riparian Lands

35+ points: incredible
25–35 points: excellent
15–25 points: good–very good
10–15 points: fair–good
5–10 points: needs work
0–5 points: your river needs help!

Protection for River Water: Quantity and Quality

12–15 points: excellent
9–12 points: very good
6–9 points: good
3–6 points: fair
0–3 points: your river needs help!

RIVERWAYS COMMUNITY REPORT CARD

COMMUNITY NAME: ______________________________

NAME RIVERS AND STREAMS IN COMMUNITY: ______________________________

____

REPORTERS' NAMES: ______________________________

NAME OF PERSON(S) INTERVIEWED: ______________________________

____

____

DATE: ______________________________

HOW DOES YOUR COMMUNITY RATE IN PROTECTION OF LAND ADJACENT TO RIVERS?

A. Land: preservation in place: (2 points for every 10 percent of river miles which have been protected)

1. What percentage of the land adjacent to rivers in your town is in public ownership or protected by Conservation Restrictions, or protected by a building setback (buffer zone)?

   Total miles along the river: _____

   _____ Percentage that is protected by public ownership:

   _____ Percentage that is permanently protected by CRs:

   _____ Percentage that is protected by river buffer zone:

2. Enforcement: Are the protection devices (CRs and buffer zones) enforced? (same scoring as above). Add 2 points for each 10% river land in public ownership.

B. Land: regulatory protection: (2 points if completed; 1 point if in planning stages)

Yes Plan No **Does your community have?**

○ ○ ○ 3. floodplain zoning which prevents building in the floodplain? (1 point for minimum floodplain zoning)

○ ○ ○ 4. zoning which prohibits industrial uses, landfills, hazardous waste sites next to the river?

○ ○ ○ 5. a local Wetlands Bylaw which gives additional protection to river banks?

C. Land Preservation tools: (2 points if completed; 1 point if in planning stages)

Yes Plan No **Does your community have?**

○ ○ ○ 6. maps which include the rivers, principal tributaries, adjacent lands and related wetlands?

○ ○ ○ 7. a practice of working with state agencies or private land trusts to purchase open spaces, particularly wetlands and along rivers?

○ ○ ○ 8. an approved open space plan (necessary for self-help funds) which includes recommendations for river protection

○ ○ ○ 9. a program by the Board of Assessors to give property tax abatements to those who have conserved land by placing permanent Conservation Restrictions on the land?

○ ○ ○ 10. lands along the river under Chapter 61, 61A, and 61B? (State program to protect lands for forestry, agriculture and recreation). {1 point}.

Other Programs:

Yes Plan No **Does your community have?**

○ ○ ○ 11. any other programs designed to help the river? please list each program at the bottom of this page. (Give each answer 2 points.) For example, cluster zoning along the river to preserve greenway

○ ○ ○ 12. an advisory committee focused on river protection? it could be called a greenway committee or be a subcommittee of the Planning Board or Conservation Commission) which

- advises on river issues
- has an ongoing program to advise landowners on environmentally sensitive issues and/or on land conservation options and tax ramifications?

RIPARIAN LAND PROTECTION SCORING

SCORING:

A "yes" answer receives two points; a "plan" answer receives one point, and a "no" answer receives no points. (A "plan" answer means concrete plans are in the works; it does not mean good intentions.)

Protection for Riparian Lands

35+ points: incredible
25–35 points: excellent
15–25 points: good–very good
10–15 points: fair–good
5–10 points: needs work
0–5 points: your river needs help!

HOW DOES YOUR COMMUNITY RATE IN PROTECTING RIVER QUANTITY AND QUALITY?

WATER:

A. Regulations and Bylaws relating to water quality: Does your community have: (2 points each, unless otherwise indicated)

Yes Plan No **Non-point source pollution abatement:**

○ ○ ○ 1. aquifer (1 point) or watershed zone which includes the river and adjacent lands (2 points)?

○ ○ ○ 2. bylaws (or Board of Health regulations) governing underground storage tanks and/or hazardous materials?

○ ○ ○ 3. Board of Health regulations requiring septic system inspections (perhaps tied to sale of houses and businesses) or septic system pump-outs?

○ ○ ○ 4. Board of Health regulations increasing minimum protection given by Title V of the State Environmental Code?
- distance from wells and reservoirs
- distance from rivers
- distance from the water table

○ ○ ○ 5. a reduced road salt program near rivers?

Point source pollution abatement:

○ ○ ○ 6. for towns with wastewater treatment plants or other NPDES dischargers (2 points each):
- are operators sensitive to river protection concerns?
- is system in compliance? (has this been monitored?)
- has town paid for needed upgrading?

B. Conservation of water: (2 points each)

Yes Plan No **Does your community have?**

○ ○ ○ 7. an official water conservation program explaining the importance of reducing water use to
- reduce the need for additional water sources (**may affect river quantity)**
- reduce wastewater? (**may affect river quality)**

○ ○ ○ 8. a program which provides for: (2 points each)
- 100% metering for the system?
- enterprise accounting with proceeds directed toward aquifer/watershed land purchase
- leak repair so that there is less than 5% unaccounted for water?

Prepared by the Riverways Programs (with thanks to Gregor McGregor, Esq.)

SCORING:

A "yes" answer receives two points; a "plan" answer receives one point, and a "no" answer receives no points. (A "plan" answer means concrete plans are in the works; it does not mean good intentions.)

Protection for River Water: Quantity and Quality

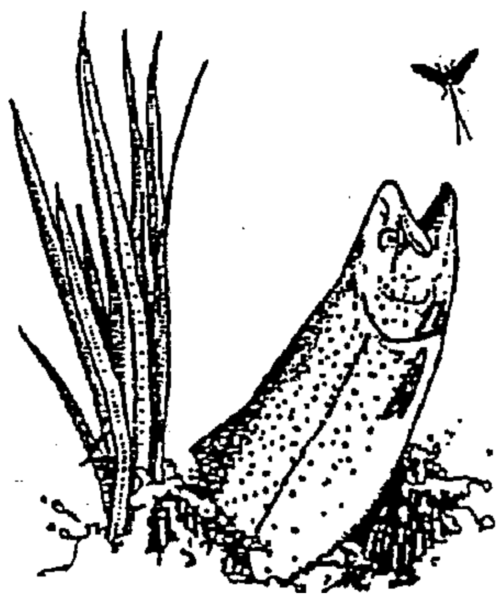
12–15 points: excellent
9–12 points: very good
6–9 points: good
3–6 points: fair
0–3 points: your river needs help!

Adopt a Stream

SHORELINE SURVEYS

A Stream Team Monitoring Project and Action Tool

Data Sheets



Riverways/Adopt-A-Stream Program Staff
Rachel Calabro, Program Coordinator
Amy Singler, Stream Team Organizer

Massachusetts Riverways Programs, Adopt-A-Stream Program
Department of Fisheries, Wildlife, and Environmental Law Enforcement

Adopt-A-Stream Program: 617-626-1549
FAX: 617-626-1505

Adapted from Shoreline Surveys Leaders' Manual, Publication No.17795-94-500-2.08 CIR
Approved by Philmore Anderson III, State Purchasing Agent

Prepared by
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Assisted by
Maria Van Dusen, Riverways Program Coordinator
Karen I. Pelto, Stream Ecologist

Tips for Shoreline Surveyors

Safety and Legalities

- Always walk with someone.
- Watch out for irate dogs. Walk cautiously and practice good dog etiquette.
- Do not drink the river water.
- Lifejackets are required by law for each person in the canoe.
- From September 15 to May 15 all canoe or kayak occupants must wear a U.S. Coast Guard Approved Personal Flotation Device.
- Wear long-sleeved shirts and pants to protect against, ticks, mosquitoes, poison ivy and nettles.
- Wear insect repellent if necessary.
- Consider landowner rights. Ask permission to cross private land, posted or not.
- Do not enter posted areas without permission. Take advantage of any public access points.

Environment:

- Don't walk on unstable banks; your footsteps could speed erosion.
- Be aware of wildlife and animal homes, for both of your sakes.

NEVER PUT YOURSELF INTO DANGER TO GATHER SURVEY INFORMATION.

If at anytime you feel uncomfortable about the stream conditions or surroundings, please STOP your Shoreline Survey. You and your safety are much more valuable than any of the objectives of the Shoreline Survey.

Checklist: What to take on your Survey

___ A buddy
___ Data sheets and map
___ Clipboard or other surface for writing
___ Two pencils – color is good to mark on maps
___ Long-sleeved, snag-free clothing /pants (for bugs and thorns)
___ Sunblock
___ Sunglasses (polarized to see into the water better)
___ Lifejackets & paddles if canoeing
___ Camera and film
___ Gloves
___ Copy of letter sent out to landowners

Optional:

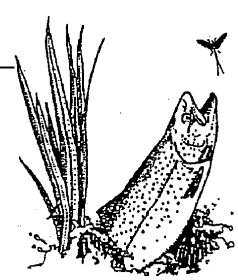
___ Rubber boots or waders
___ Yardstick or measuring tape (useful for pipes)
___ Compass
___ Field guides (in ziplock bags)
___ Food, for energy!

What you need to do:

Tonight: Coordinate with your segment team. Arrange canoes, meeting place, etc.

This weekend: Conduct the survey! Fill out the data sheets while you're on the river.
With your team, fill out the *Summary Sheets*—the segment description and the priority Sheet--after you are finished surveying your segment.
Return all *Data* and *Summary Sheets* (one set per team) to:
____
____ Return by: ___________

This month: Attend action planning meeting, which will be held: _____________



Massachusetts Riverways Programs/DFWELE

Shoreline Survey Field Data Sheet *Adopt a Stream*

Segment begins: ________________
Segment ends: __________________

Date:____
Observers:____
Today's weather:____
Weather over past 24 -48 hours:_________________________________

If you take photographs, mark the location on the map, and write it on the backs of the photos, along with date. Be specific (reference nearby road or house), so that people can compare later photos

INSTREAM CONDITIONS

Stream bottom

1. What is stream bottom made of? (*mark from 1=most typical to 6=least typical)*

____Organic debris (leaves, twigs) _____ Gravel (1/4 - 2")
____Silt (mud) _____Cobbles (2 -10')
____Sand (l/l6 to 1/4") _____Boulders (> 10")

2. What color is the stream bottom? *(circle one)*

Black Brown Orange/Red Yellow Sandy Gray Other

Water

3. What color is the water? *(circle)* Cloudy Tea Milky Muddy Other _____________

4. What is the water odor? (circle) None Rotten eggs Musky Fishy Oily Ammonia Other

5. Problem areas*. (checkmark, describe location and cause, if apparent. *Locate on map.)*
___ Oily sheen or smell ____
___ Sewage: smell, milky color, toilet paper ____
___ Foam or scum *(describe. Does a stick break it up?)* __________________________________
___ Fishy odor or fish kill ____
___ Floating garbage ____
___ Excess sedimentation ____

6. How deep is the water? *(circle)* Less than 1' More than 1' More than 2' More than 3'

7. How does the water level compare to normal for this time of year? (*circle*)
Normal Higher Lower Don't know If very high or low, can you tell why?

8. Is the water flowing *(circle)* Quickly Slightly Almost still

9. Number of pools Number of riffles Don't know

10. Is stream flow blocked *by...(circle and *locate on map.*) Trees Trash Large objects

Vegetation

11. Are there areas of extremely dense or clogging aquatic vegetation in any section? *(circle)* Yes No
**If yes, locate on map and describe cause, if obvious.* ____
Species, if known *(circle)* Duckweed Water chestnut Other ____________________

12. Are there areas covered with algae? *(Circle)* Streambed Around pipes
*lf algae seems abnormally heavy, *locate on map. Draw in extent of algae on map.*

13. Are there wetlands? (*Circle. *locate on map*.) Yes No If yes, are they degraded by... (*circle*)
Phragmites Purple Loosestrife Fill Blockages Ditches
Sediment Disturbed banks Pipes Trash Other ______________

STREAM CORRIDOR CONDITIONS

Riparian Area and Land Use

14. Do trees and shrubs overhang the stream and provide shade? (circle) Yes No
    If yes, estimate what percentage of the bank is shaded

15. What are the stream bank conditions? *(circle. Put a star* next to the most common.)*
    Left Bank: (Looking downstream) (If doing only one bank, indicate which one)
    Eroding Moss Trees/Shrubs Exposed Roots Grass/Flowers Loosestrife/Phragmites
    Beaches Riprap/channelized Shrubs/brambles Wetlands/marsh
    Right Bank: Eroding Moss Trees/Shrubs Exposed Roots Grass/Flowers Loosestrife/Phragmites
    Beaches Riprap/channelized Shrubs/brambles Wetlands/marsh

16. Is there a vegetated riparian area beyond the stream bank? If yes, indicate condition.
    *(circle. Put a star*next to the most common.)*
    Left Bank: Shrubs/grasses mowed pasture/meadow Forested/trees Park with few trees Lawn
    Right Bank: Shrubs/grasses mowed pasture/meadow Forested/trees Park with few trees Lawn
    If area is not vegetated, please describe condition: (i.e. parking lot, pavement, roadway, buildings)
    Left Bank:____
    Right Bank:____

17. If the riparian area is forested or in shrubs and grasses, estimate width of the vegetated area (to a lawn, road, or other change in land use) left bank ____________________ right bank______________________

18. Are there places that have fill or clear-cutting? *(circle)* Yes No
    If yes, mark locations on map as fill F1, F2, F3. Etc (or clear-cutting CC1 CC2, CC3, etc).

19. What are the land uses visible from the river? (*checkmark and circle the dominant land use type*.)
    ___ Industrial ___ Parking lots ___ Golf courses
    ___ Commercial ___ Roads ___ Protected/conservation land
    ___ Agricultural ___ Landfills ___ Undeveloped/unprotected land
    ___ Residential ___ Railroads ___ Wastewater treatment plants
    ___ Park/ ballfields ___ Junkyards ___ Wooded areas ____Other *(describe)*

20. Do you see runoff from any of the following? *(circle. *If run-off is significant locate on map.)*
    Manure Pet / goose droppings Parking lots Sewage Roads
    Bridges Construction Plowed fields Lawns Other____________

Pipes: Please fill out separate pipe survey and mark locations on map as P1, P2, P3, etc.

Trash: Describe any potential cleanup areas. **Locate on map.*

Potential Open Space: *Describe and locate on map:* ____.

Recreation

21. Is there designated public access to the stream? Is it appropriate for… *(circle and *locate on map.)*
    Canoeing Fishing Swimming Walking Bicycling Other____________

22. Are there areas which are informal or potential access points? No Yes- *Describe and *locate on map.*

WILDLIFE / HABITAT

Aquatic Habitat/Species

23. Do you see fish or evidence of fish? (describe)____

Estimate number _____________. *If possible, describe species & size*.___________________________
Evidence of fish? (i.e. nests) _______________________________

24. Other forms of aquatic life? *(circle, identify species if known)*

Aquatic insects   Turtles   Frogs   Salamander   Snail   Mussels   Snakes   Clams
Other_______________________
Evidence of aquatic species? (i.e. eggs, tracks) _______________________

25. Wildlife and fish habitat elements present in water *(check)*

__ Pools and riffles in stream
__ Gravel stream bottom
__ Rocks and boulders in stream
__ Emergent aquatic vegetation
__ Vegetation hanging over the banks and water
__ Fallen trees in water
__ Undercut banks

Riparian Habitat/Species (look along stream bank and vegetated riparian areas)

26. Animals or evidence of animals? *(circle)*

Holes   Teeth marks   Food storage/eating   Dens   Scat   Footprints/tracks
Specific animals seen (or evidence of)____

27. Wildlife habitat elements located near the stream *(check)*

__Standing dead trees
__Fallen tree limbs and trunks
__Scattered rocks and boulders
__Stone walls (without cement)
__Vines
__Springs and seeps
__Vernal pools

28. Birds? (circle)   Herons   Mallard ducks   Wood ducks   Kingfishers   Canada geese   Other___________

Evidence of birds: (i.e. nests, footprints) ___________________________

29. Do you know if there are rare & endangered species of plants or animals in your segment? *If so, identify*.

____

30. Links from riparian area to other areas of wildlife habitat: *(check)*

__Wetlands adjacent to stream
__Abandoned cropland or pasture near stream
__The riparian area is vegetated with trees and/or shrubs at least 100 feet wide
__The riparian area connects to adjacent open space or greenway

Optional: Additional Questions and notes.

Segment begins: ________________
Segment ends: ________________

As much as we try, our Shoreline Survey Forms do not always cover all possible questions and angles. If there are additional potential problems or features that your Stream Team decided were not adequately addressed, please make note of them here. Or, use this space for extra notes as you do your survey.

Adopt a Stream

Shoreline Survey Summary Sheet

Segment begins: ________________
Segment ends: _________________

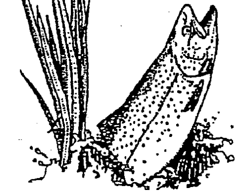
Date:____
Observers:____
Today's weather:____
Weather over past 24 -48 hours:__________________________

These sheets are designed to give the "big picture" of your segment. They provide the basis of the narrative description of segments in the Shoreline Survey report.

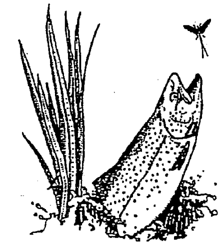
NARRATIVE DESCRIPTION

SAMPLE 1: The river flows slowly through this segment. The banks on the south side are eroded for a distance of about 100 yards (a football field), with parkland behind it. On the other side of the river, the banks have cement walls, industrial buildings and parking lots. There was a marsh at the lower end. A small stream came into the river, and the water quality seemed worse after it entered. Bits of oil floated on the water, and the stream smelled like asphalt. There were a few gulls in the industrial section, and there were turtles, a muskrat hole and a great blue heron in the wetland/marsh.
SAMPLE 2: Segment 2 flows quickly through conservation land, with several small riffles. We saw several anglers along the banks. There were many downed trees in the stream, which provide good habitat for fish. Vegetation along the stream is thick, second-growth forest with an old dirt road providing good access for walking or mountain biking. There are several old appliances in the river near the Rt. 20 bridge.

Describe your segment in a paragraph:



Adopt-A-Stream Pipe Survey of ________________________ River/Brook



Segment #_________
Segment Begins: ______________
Date: _____________________________
Segment Ends: _______________
Names of observers: ____
Weather today: ____
Weather over past 48-72 hours: ____

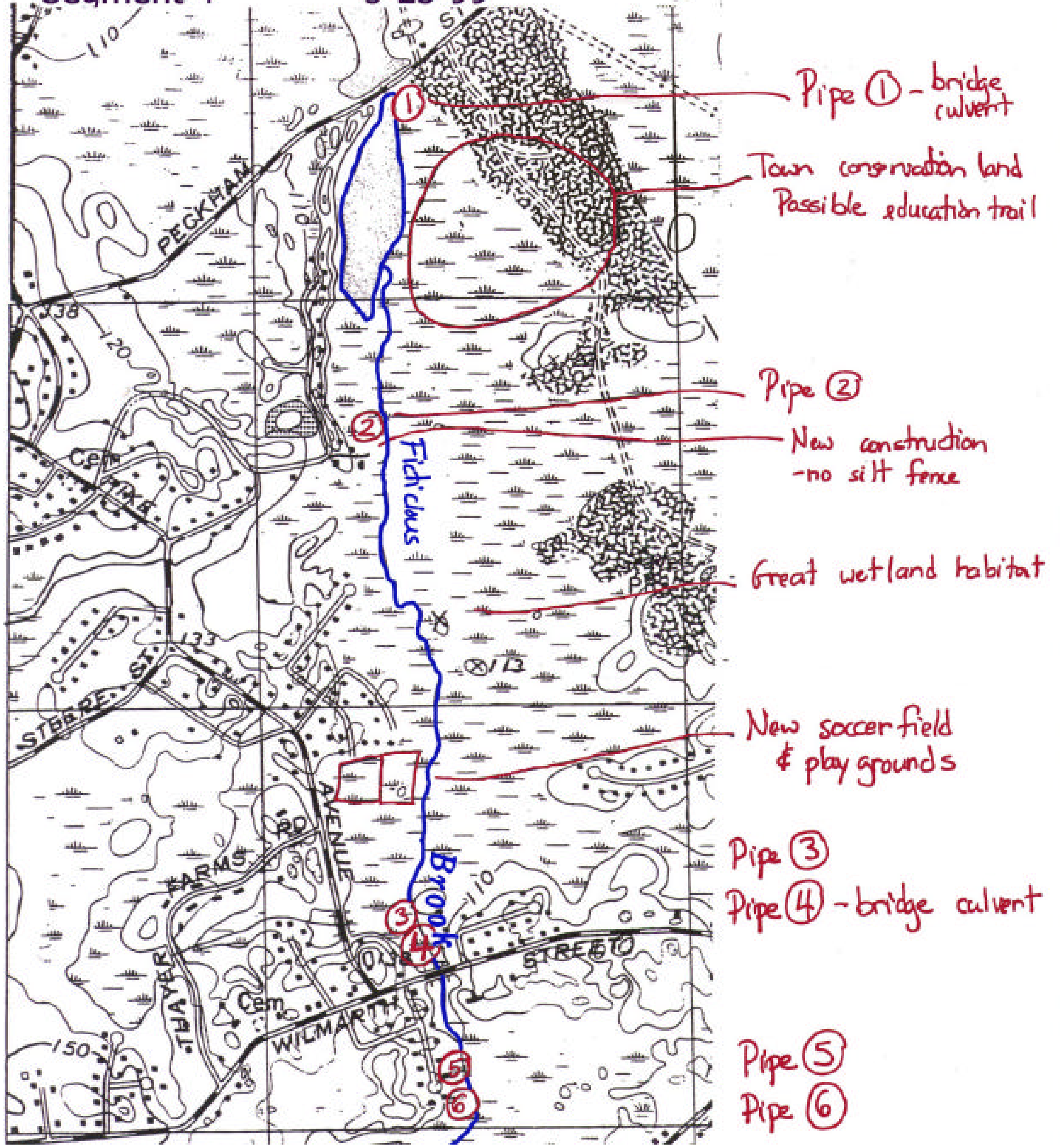
Pipe#	Time	**Pipe material and condition**	**Pipe size & amount of flow**	**Color of Flow**	**Odor of Flow**	**Algae below pipe** Yes No Describe extent	**Sediment below pipe**	**Comments? If pipe should be rechecked- describe location**	**GPS Latitude GPS Longitude: (Optional)**
Sample #1	9:33 AM	Concrete in good shape	Constant Moderate Flow 1' diameter	Red-brown	fetid	Green growth coating rocks across the entire stream width and 100 yards upstream.	Sand accumulation at outfall	Should be rechecked. Downstream of Jones St. Bridge	

Shoreline Survey Priorities for Action Adopt a Stream

Segment Begins: ____________________
Segment Ends: ______________________

Look back at your Field Data sheet and include your observations. The information from these sheets will be used to develop the Action Plan. PROBLEMS: Problems found in your segment, such as: pipes discharging in dry weather erosion, runoff trash, dense algae water quality problems (odor, color, oil, foam, sewage) degraded wetlands (phragmites, loosestrife) other problems *(describe, give location)* 1. 2.	ASSETS: Assets found in your segment, such as: Good habitat, wildlife species businesses or landowners using the river (in a friendly way) recreational access (canoe, trails, parks) potential recreational access potential park/conservation land *(describe, give location)* 1. 2.	PRIORITIES for action: List items from problems/assets columns that you feel need more work. 1. 2.

SAMPLE SHORELINE SURVEY MAP
Ficticious Brook, Anytown
Segment 4 5-23-99



Where You At? A Bioregional Quiz

This quiz was first published in Co-Evolution Quarterly in the early 1980s by Leonard Charles, Jim Dodge, Lynn Milliman, and Victoria Stockley.

Coevolution Quarterly 32 (Winter 1981): 1.

1. Trace the water you drink from precipiation to tap.
2. How many days til the moon is full? (Slack of 2 days allowed.)
3. What soil series are you standing on ?
4. What was the total rainfall in your area last year (July-June)? (Slack: 1 inch for every 20 inches.)
5. When was the last time a fire burned in your area?
6. What were the primary subsistence techniques of the culture that lived in your area before you?
7. Name 5 edible plants in your region and their season(s) of availability.
8. From what direction do winter storms generally come in your region?
9. Where does your garbage go?
10. How long is the growing season where you live?
11. On what day of the year are the shadows the shortest where you live?
12. When do the deer rut in your region, and when are the young born?
13. Name five grasses in your area. Are any of them native?
14. Name five resident and five migratory birds in your area.
15. What is the land use history of where you live?
16. What primary ecological event/process influenced the land form where you live? (Bonus special: what's the evidence?)
17. What species have become extinct in your area?
18. What are the major plant associations in your region?
19. From where you're reading this, point north.
20. What spring wildflower is consistently among the first to bloom where you live?

Scoring

- 0-3 You have your head up your ass.
- 4-7 It's hard to be in two places at once when you're not anywhere at all.
- 8-12 A firm grasp of the obvious.
- 13-16 You're paying attention.
- 17-19 You know where you're at.
- 20 You not only know where you're at, you know where it's at.

Point Count Data Form (VER. 4/27/00)		Page: of:
DATE		FIELD NOTES:
OBSERVER:	SITE NAME	
STATE:	VISIT NUMBER:	
PROVINCE:	WEATHER:	
AREA ID:	WIND:	

			TYPICAL DETECTION				FLYOVERS				JUV	FLUSH	FIELD NOTES
			0 to 50m		> 50m		ASSOC.		IND.		CNT	CNT	
STN #	START TIME	SPP. CODE	0-3 MIN	3-5 MIN	0-3 MIN	3-5 MIN	0-3 MIN	3-5 MIN	0-3 MIN	3-5 MIN			

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

Water Snapshot 2002 April 19 - 28

An informal, water quality monitoring survey conducted throughout the Delaware River Basin

Sample as many locations and provide as much of the requested information as possible. Complete one data sheet for each location. Don't forget to obtain landowner permission before entering private property! Please return completed forms **before May 31, 2002,** to: Clarke Rupert, Delaware River Basin Commission, P.O. Box 7360, West Trenton, NJ 08628. By submitting data sheets, you are giving permission to have the information published in future Snapshot reports. **Questions?** Visit the DRBC web site at **www.drbc.net** or call (609) 883-9500 x 260. *Thank you for participating!*

1) ____________________ ____________________ (____)____________
NAME E-MAIL ADDRESS PHONE NUMBER

2) ____________________ **3)** ____________________
SCHOOL, COMPANY OR ORGANIZATION TEACHER (IF APPLICABLE)

4) ____________________ ____________________ ____ ______
COMPLETE MAILING ADDRESS CITY STATE ZIP

5) ____________________ ____________________ ____________ ____
SAMPLING LOCATION - NAME OF WATER BODY MUNICIPALITY COUNTY STATE

6) Location relative to known/mapped landmark (e.g. road, bridge, building) ____________________

____

7) Approximate width of stream: feet **8)** Date & hour of data collection:

WEATHER CONDITIONS

9) Was there precipitation within the past 48 hours**?** YES NO **10)** Air Temperature:_______ ^{o}C

11) Description: SUNNY - PARTLY CLOUDY - OVERCAST - RAIN

WATER QUALITY *(milligrams per liter, or mg/l = parts per million, or ppm)*

12) __________ **13)** ______ **14)** ______________ **15)** ______________ **16)** ____________
WATER TEMP. (^{o}C) pH DISSOLVED OXYGEN (mg/l) CONDUCTIVITY (umhos/cm) WATER DEPTH (meters)

17) ____________ **18)** ____________ **19)** Flow of stream or capacity status of impoundment:
NITRATE (mg/l) PHOSPHATE (mg/l) **a.** less than normal **b.** normal **c.** greater than normal **d.** unknown

20) Other tests: ____

____
(Record any other water quality test data that you collected at this site; if needed, attach separate sheet.)

21) What instruments, meters, and equipment did you use? ____________________

____

22) Is the water cloudy? NO - SOMEWHAT - VERY

23) Aquatic life observed: ALGAE - ROOTED PLANTS - FISH - AMPHIBIANS - INVERTEBRATES
(Other, please describe)____

____

VISUAL ASSESSMENT of SMALL (WADEABLE) STREAMS

Look at the stream and surrounding area for 50 yds. upstream and 50 yds. downstream of your sampling site.

Put an "X" directly over the best response to each assessment factor.

ASSESSMENT FACTOR	RESPONSE: EXCELLENT	GOOD	MARGINAL	POOR
1. Instream cover (habitat for fish & aquatic organisms)	The stream contains lots of boulders (over 10"), cobble (2-10"), submerged logs, undercut banks or other stable habitat	There is adequate habitat of both rock & wood for maintenance of diverse populations of fish & bugs	Some rock and wood or other stable habitat, but much less than desirable	Not much stable habitat; lack of habitat is obvious
2. Fine particle sediments (sand, silt, mud)	The rocks in the stream are not surrounded by fine sediments; I see very little sand, silt, or mud on the bottom	Rocks are partly surrounded by fine sediments; I could easily flip over the rocks on the bottom	Rocks are more than half surrounded by fine sediments; rocks are firmly stuck into sediments	Rocks are deeply stuck into fine sediments; bottom is mostly sand, silt, or mud
3. "Flow patterns": How many does the stream have?	All 4 of these velocity/depth patterns are present within 50 yards upstream or downstream of this site: **slow/deep, slow/shallow, fast/deep, fast/shallow**	Only 3 of 4 regimes (flow patterns) are present	Only 2 of the 4 regimes present	Dominated by one velocity/depth regime
4. Condition of banks & coverage? (If the two banks are very different, assess the worse side, if possible)	The banks are stable; no evidence of erosion or bank failure; the whole bank is covered with vegetation or rock	Moderately stable; some small areas of erosion mostly healed over; most of the bank is covered by vegetation or rock	Largely unstable; almost half of the bank has areas of erosion or is NOT covered by vegetation or rock	Unstable; eroded areas; "raw" areas occur frequently; less than half of the bank is covered by vegetation or rock
5. Disruptive pressures to the "riparian" area? (If the two banks are very different, assess the worse side, if possible)	Trees, shrubs, or grasses have not been disturbed through forestry, grazing or mowing; almost all plants are growing naturally; mature trees, understory, and vegetation are present	Some disruption, but not affecting full plant growth potential to any great extent; trees, woody plants, and soft green plants are dominant	Disruption is obvious; some patches of bare soil, cultivated fields or closely cropped vegetation are the norm	There is not much natural vegetation left or it has been removed to 3 inches or less in average stubble height
6. Riparian vegetative zone width (If the two banks are very different, assess the worse side, if possible)	Riparian zone is more than 35 yards wide; human activities (parking lots, roads, clearcuts, lawns, or crops) have not impacted zone	Riparian zone 12-35 yards wide; human activities have impacted zone only minimally	Width of riparian zone 6-12 yards; human activities impacting zone are commonly evident	Width of riparian zone is less than 6 yards; lots of nearby human activities
7. Litter	There is no litter in the area	There is very little litter in the area; probably some degradable paper accidentally dropped by fishermen or hikers	Litter is fairly common and includes metal or plastic, obviously purposely dropped.	Area is a candidate for a clean-up project; lots of litter, dumping, tires, or barrels present
8. Overall I rate the VISUAL ASSESSMENT of this site …	EXCELLENT	GOOD	MARGINAL	POOR

DEFINITIONS:

Riparian zone - The land connected with or immediately adjacent to the banks of a stream or other body of water.
Disruptive pressure - Any activities which interfere with the natural unity of a system. In the case of riparian assessment, this usually refers to land use practices such as mowing, grazing, logging, paving, building construction, heavily worn paths, etc.
Habitat - The "places" where a plant or animal normally lives and grows throughout all the phases of its life cycle.
Stable Habitat - The condition in which places used for hiding, resting, reproducing, living, and growing are not undergoing rapid or constant change. In the case of stream assessment, this is usually referring to large rocks, logs, and undercut banks which are more or less permanently in place.

The DRBC and several organizations originally conceived the WATER SNAPSHOT project in 1996. DRBC leads the annual effort, with the valuable assistance of a committee consisting of representatives from the following organizations: Del. Dept. of Natural Resources and Environmental Control, Delaware Riverkeeper Network, Delaware Estuary Program, National Park Service, N.J. Dept. of Environmental Protection, N.Y. State Dept. of Environmental Conservation, Pa. Dept. of Conservation and Natural Resources, Pa. Dept. of Environmental Protection, Pennsylvania Environmental Council, Pocono Environmental Education Center, Upper Delaware Council, U.S. Environmental Protection Agency, and U.S. Geological Survey.

Project Sponsor Form

Thank you for your interest in sponsoring a wetlands restoration project. Sponsoring a wetland restoration project and seeing it through to completion is very rewarding but is also a big commitment that requires time, energy, and work. If you would like to know more about being a project sponsor, we would be happy to send you our informational guide, A Citizen's Guide to Restoring Massachusetts Wetlands. If you would like to be a sponsor, please fill out this form and return to the address below. Thank you. We look forward to working with you to restore Massachusetts' wetlands!

Name ____

Organization (if any) ____

Mailing Address ____
Street/P.O. Box City/Town State/Zip

Home Address ____
Street/P.O. Box City/Town State/Zip

Business Phone ____________________________ Home Phone ______________________________

FAX No. ___________________________________ E-Mail _________________________________

Do you know of a wetland restoration project that you would like to sponsor? _________________

If yes, please explain: ____
____

Do you have any background in wetlands? ____ If yes, please explain _______________________
____

Are you willing to sponsor a project outside of your community? ____________________________

Comments ____
____

Please return this completed form to:
Steve Block
Wetlands Restoration & Banking Program
One Winter Street – 5th Floor
Boston, MA 02108
Phone: (617) 292-5743
FAX: (617) 292-5850
Email: steve.block@state.ma.us

Wetlands Restoration & Banking Program
GROWetlands
Wetlands Restoration Project Nomination Form

Thank you for your interest in restoring Massachusetts' wetlands. If you wish to sponsor a wetland restoration project and would like to propose that it be considered part of the statewide wetlands restoration initiative called GROWetlands (Groups Restoring Our Wetlands) under the Massachusetts Wetlands Restoration & Banking Program, please fill out this form and return to the address below.

Project Name: ____

Project Location: City/Town __________________ Watershed ______________________________

Please attach a USGS quad sheet or other map on which the site location has been marked.

If available, please attach current and historic photos and aerial photos of the project site.

Project Sponsor: ____

Designated Representative: ____

Telephone: ___________________ FAX ________________ EMail __________________________

Address: ____

Project Co-Sponsors: ____

Landowner: ____

Has landowner expressed support for wetland restoration at the site? Yes ___ No ___
Explain:

Is all or part of the wetland totally destroyed or does it exist in a degraded condition? Explain:

Briefly describe the current condition of the wetland to be restored.

Wetlands Restoration Project Nomination Form (page 2)

Is the wetland part of an agricultural facility or was it farmland in the past?
___ Is in agricultural use now. ___ Was never farmed.___ Was formerly agricultural land. Explain:

What caused the impact to the wetland?

Is the wetland area under an outstanding enforcement order? Yes ___ No ___ If yes, explain:

What is the approximate size of the area proposed to be restored?

What is the approximate size of adjacent wetland areas, if any?

Please attach a sketch of the area showing the wetland to be restored, adjacent wetlands and waterbodies, roads and buildings in the immediate vicinity, and other pertinent information to describe the site. If possible, indicate different wetland types that are present (Phragmites swamp, wet meadow, forested wetland, etc.).

If known, what was the wetland type(s) prior to impact?

If known, what restoration activity would be required to restore the wetland?

If known, what is the approximate cost of the restoration?

Has any funding been identified for this project? Yes ___ No ___
If yes, describe:

Would you like WRBP to arrange a site visit and project evaluation? Yes ___ No ___

Signed: ____ Date: __________________________

Please send this form with attachments to:
Steve Block
Wetlands Restoration & Banking Program
One Winter Street – 5th Floor
Boston, MA 02108
Phone: (617) 292-5743
FAX: (617) 292-5850
Email: steve.block@state.ma.us

A representative of WRBP will contact you as soon as possible. Please call us if you have any questions.
Wetlands Restoration & Banking Program

Conducting a site/habitat inventory – Pieces, Patterns, and Process

1) Equipment – Once you're out in the field, you want to have everything you'll need.

Proper dress: pants, sturdy shoes, socks, longs sleeves, hat, bandanna – you don't want to shy from getting wet, dirty, scratched, etc. because you have the wrong clothes; so use old, sturdy clothing, always wear pants (tucked into socks) and long sleeves; a hat is essential to avoid sunburn, and a bandanna can be good for keeping flies off. If you'll definitely be getting wet, consider high rubber boots, tevas over neoprene booties, or bring an extra pair of socks. Raingear, layers?

bag or vest: a MountainSmith or other large butt pack or day pack or a fishing vest.

water, food: again, you don't want to cut a field day short because of thirst/hunger.

Essentials: waterproof notebook/pencil, hand lens, pocket knife, compass, ruler, binoculars, watch, collecting vial, Ziplocs; **optional**: gps, digital camera, plant press, dbh tape, increment borer, etc.

Field references: ferns, herbs, trees, birds, etc., etc.

Other references: Gleason&Cronquist, Peterson guides, Natural Communities of Massachusetts, etc.

2) Preparation

Research: bedrock/surficial geology, Priority Habitat, context, ownership, access, parking, etc.

A Plan: why are we doing the inventory?

- For a species list (which groups?)
- To inform management
- Invasives control
- For CR monitoring
- For long-term monitoring/research

Timing: season (birds/frogs calling, butterflies present, tracking in snow, Spring ephemerals, etc.); time of day (morning/evening vocalizations), weather conditions, etc.

Maps: aerial/topo, identify study area, draft natural communities/cover types, plan a route to visit all areas of interest, and have an 'exit plan.'

3) **Methods**

Natural community/stand description – natural communities can be used as a short-hand for plant/animal habitat and to designate management areas.

- Canopy: species, relative abundance, height, percent cover, average dbh
- Shrub: species, relative abundance, percent cover
- Ground: species, relative abundance, percent cover
- * notes on invasives – where they are, are they spreading, dominant, etc.

Animals:

- record species encountered (birdcalls, animal tracks or other sign, butterflies, dragonflies, etc.)
- active searching: turning cover to find snakes, salamanders
- collecting: invertebrates (pitfalls, sweep nets, etc.), minnow traps
- systematic sampling: point counts, transects, etc.

Habitat Elements: makes notes on the number and size of dead trees standing and on the ground ("coarse woody debris"), outcrops and talus slopes, seeps and springs, caves, stone walls, etc.

Landuse History: make notes on evidence of logging, pasturage, agriculture, old foundation holes, roads, etc. Make an effort to assign ages (using white pine whorls, dbh, canopy height, species assemblage, etc.)

Current landuse: firepits, ATV/dirt bike/horse/mountain bike tracks, litter, user 'interviews'

Landmarks: record water bodies, stone walls, paths, roads, etc. so you can key your notes to specific sites in the field.

4) Recording

* Transcribe notes as soon as possible
* Label photos/specimens, with dates, locations, collector's name
* Map locations as well as possible; refine community boundaries; note changes since latest photo.
* Track down records that you think might be of interest to others: unusual sightings, etc.
* Synthesize notes so that information 1) makes sense to *you*, and 2) is useful to another user.

The Nature of Massachusetts: *An Approach to the Study of Biological Communities in Relation to Environment*

Part 1. Location and Sampling History

Sanctuary/Site:	*Sampled by:* *Date:*
Transect No.: ______ *Plot No.:* _______ *Plot Size:* _______ *sq. m*	*Sampled by:* *Date:*
Plot Shape: circle (5.64 or 11.28 m rad.), rectangle (______ by ______m)	*Transect Diagram and/or Plot Location:*
County:	
Town:	
Quadrangle:	
Elevation:	
Latitude:	
Longitude:	

Part 2. Environmental Characterization

Topographic Position, or Landform	*Aspect*	*Slope Class (degrees)*	*Slope Shape*	*Surface Substrate (%)*	*Soil Moisture Regime*	*Inundation*
Summit/Crest	Flat	Flat (<1)	*Vertically:*		Very Xeric (moist for negligible time after ppt.)	Never
Shoulder	Variable	Gentle (1-5)	Concave	____ Litter/Duff	Xeric (moist for brief time)	Infrequently, most years not inundated
Back Slope	N	Average (5-14)	Convex	____ Decaying Wood	Somewhat Xeric (moist for short time)	Frequently, periods of short duration
Escarpment	NE	Rather Steep (14-26)	Straight	____ Bedrock	Submesic (moist for moderately short time)	Annually, < 6 mos. continuous
Foot Slope	E	Steep (26-45)	*Horizontally.*	____ Boulders (>24 in.)	Mesic (moist for significant time)	Annually, > 6 mos. continuous
Toe Slope	SE	Very Steep (45-70)	Concave	____ Stones (10-24 in.)	Subhygric (wet for significant time)	Always Submerged
Rolling Terrain	S	Abrupt (>70)	Convex	____ Cobbles (3-10 in.)	Hygric (wet for most of growing season)	Tidal? Yes No
Plain	SW	(measured): _______	Straight	____ Gravel	Subhydric (water at or near surface all year)	Saltwater
Terrace	W			____ Mineral soil	Hydric (water at or above surface all year)	Brackish
Flood Plain	NW			____ Peat		Freshwater
Basin	(measured): _______			____ Muck		
Dune				____ Water	*Unusual Climatic Conditions*	*Important Ecological Processes*
Beach / Shore				____ (other, describe)	Cold Air Accumulation, Late Frost	Water Erosion or Sedimentation
Wetland / Vernal Pool				100% TOTAL	Moderated Maritime Temperatures	Wind Erosion or Sedimentation
Lake / Pond					Exposure to Strong Winds	Periodic Flooding / Tidal Regime
Stream					Frequent Damaging Ice Storms	Pronounced Colluvial Processes
(other, describe):					(other, describe):	Fire
						(other, describe)

Bedrock Geology Map Unit:	*Surficial Geology Map Unit:*	*Soil Map Unit:*
Petrography:	*Type of Deposit*	*Soil Series Classification:*

Type of Deposit
Till and/or Bedrock
Glacio-fluvial
Deltaic
Lacustrine or Fluvial
Recent Marine
Older Marine
Organic
Slope and Modified
Aeolian
(other, describe):

Lithotectonic Zone	*Nutrient Regime*
Milford-Dedham Zone	
Nashoba Zone	Oligotrophic
Merrimack Belt	Submesotrophic
Connecticut Valley Belt	Mesotrophic
CT Val. Mesozoic Basins	Permesotrophic
Bronson Hill Zone	Eutrophic
Rowe-Hawley Zone	
Taconic-Berkshire Zone	

Soil Profile Description

Horizon	Depth (in.)	Texture	Structure	Consistence	Color
			/ /		
			/ /		
			/ /		
			/ /		
			/ /		
			/ /		

Watershed

Assabet	Housatonic	Neponset
Blackstone	Hudson; Bashbish	North Coastal
Buzzards Bay	Hudson; Hoosic	North & South Rivers
Cape Cod	Hudson; Kinderhook	Parker
Charles	Ipswich	Quinebaug
Chicopee	Islands	Shawsheen
Concord & Sudbury	Merrimack	South Coastal
Connecticut	Millers	Taunton
Deerfield	Mystic	Tenmile
Farmington	Narragansett & Mt. Hope Bays	Westfield
French	Nashua	Weymouth & Weir

Chemical Analysis (A Horizon, or upper 10 cm); elements as ppm in soil

pH	P	K	Ca	Mg	NH4	NO3
CEC	B	Mn	Zn	Cu	Fe	Al

Additional Pertinent Information:

Evidence of Disturbance:

Unusual or Important Microhabitats in Plot:

Massachusetts Audubon Society

Part 3. Vegetation Structure, Physiognomy, and Dominance

DBH (cm) & Basal Area (BA, sq. cm) of trees > 10 cm DBH

Species	Species	Species	Species	Species	Species	Species
DBH / BA	DBH / BA	DBH / BA	DBH / BA	DBH / BA	DBH / BA	DBH / BA
/	/	/	/	/	/	/
/	/	/	/	/	/	/
/	/	/	/	/	/	/
/	/	/	/	/	/	/
/	/	/	/	/	/	/
/	/	/	/	/	/	/
/	/	/	/	/	/	/
/	/	/	/	/	/	/

BA Sum: ______ BA Sum: ______ BA Sum: ______ BA Sum: ______ BA Sum: ______ BA Sum: ______ BA Sum: ______

Stratum Codes, Illustrating Structure
(circle appropriate stratum codes)
Percent Cover:

Height:	<5%	5 to 20%	20 to 40%	40 to 60%	60 to 80%	80 to 100%
35 m +	35-0	35-5	35-20	35-40	35-60	35-80
20 to 35 m	20-0	20-5	20-20	20-40	20-60	20-80
15 to 20 m	15-0	15-5	15-20	15-40	15-60	15-80
10 to 15 m	10-0	10-5	10-20	10-40	10-60	10-80
6 to 10 m	6-0	6-5	6-20	6-40	6-60	6-80
shrub 1-6 m	S-0	S-5	S-20	S-40	S-60	S-80
herb < 1 m	H-0	H-5	H-20	H-40	H-60	H-80
moss / lichen	M-0	M-5	M-20	M-40	M-60	M-80

Plot Basal Area: sum of all spp./ 10,000= __________ sq. m / plot   Basal Area per Hectare: plot BA X 100 or 25= __________ sq. m / ha

Physiognomy and (up to 3) Dominant Species, by Stratum

Tree Stratum Code: Physiognomy: Decid. DE ED Everg.	Tree Stratum Code: Physiognomy: Decid. DE ED Everg.	Tree Stratum Code: Physiognomy: Decid. DE ED Everg.	Tree Stratum Code: Physiognomy: Decid. DE ED Everg.

Shrub Stratum Code: Physiognomy: Decid. DE ED Everg.	Herb Stratum Code: Physiognomy: Pter. Forb Gram. Eric.	Moss / Lichen Stratum Code: Physiognomy: Moss Lichen Liverw.	*Age of Selected Trees* Species DBH Age

Part 4. Floristic Composition and Cover-Abundance Class, by Stratum

Date:			*Date:*			*Date:*			
Stratum Code, and Species	*Cover*	*Cover*	*Stratum Code, and Species*	*Cover*	*Cover*	*Stratum Code, and Species*	*Cover*	*Cover*	Cover-
									Abundance
									Classes
									d
									totally dead
									p
									outside plot
									r
									one indiv.
									+
									several,
									<1% cover
									1-
									1 to 2%
									1+
									>2 to 5%
									2-
									>5 to 12%
									2+
									>12 to 25%
									3
									>25 to 50%
									4
									>50 to 75%
									5
									>75 to100%

Part 5. Provisional Community Name

Natural Community
FIELD FORM INSTRUCTIONS

Modified for **Massachusetts**
by Patricia Swain, MNHESP
May 10, 2001

from a 1991 draft
Lesley Sneddon, Regional Ecologist
(The Nature Conservancy
Eastern Heritage Task Force
201 Devonshire Street
Boston, Massachusetts)
now
NatureServe
Boston Office
11 Avenue de Lafayette
Boston, MA 02111

Massachusetts Natural Heritage & Endangered Species Program
Division of Fisheries and Wildlife
Rt. 135
Westborough, MA 01581

COMMUNITY FORM 1: TRANSECT, SITE SURVEY SUMMARY

rev. May, 1998

MA Natural Heritage & Endangered Species Program

A. Identifiers

1.Site name:_______________ 2.Survey site name: _______________

3.Quad name(s)_______________ 4.Quad code(s):_______________ 5.County name(s):_______________ 6.County code(s): _______________

7.Town (LOCALJURIS):_______________ 8.Directions: _______________

9.Sourcecode: _______________ 10.Survey date _________ 11.State: __________

12.Surveyors:_______________

B. Topography 13. Transect____

14.Reconnaissance diagram: Scale:

C. Vegetation / Habitat

15. Observation point 1___	Observation point 2___	Observation point 3___
16. Community name:___________ 17. Additional data: Site form___ form 3 ____	Community name:___________ Additional data: Site form____ form 3___	Community name:___________ Additional data: Site form____ form 3____
18.General description (physiognomy, char./dom spp. of tree, shrub, herb, bryophyte layers)	General description	General description:

Reconnaissance Diagram: Scale:

Observation Point 4 ___	**Observation Point 5 ___**	**Observation Point 6 ___**	**Observation Point 7 ___**
Community name:______________________ Additional data: Site form ___ form 3___	Community name:______________________ Additional data: Site form____ form 3____	Community name:______________________ Additional data: Site form____ form 3____	Community name:______________________ Additional data: Site form____ form 3____
General Description:	General Description:	General Description:	General Description:

Natural Heritage & Endangered Species Program

Massachusetts Natural Heritage & Endangered Species Program
Division of Fisheries & Wildlife
Route 135
Westborough, MA 01581
(508) 792-7270 ext. 200

FORM 2: NATURAL COMMUNITY SUMMARY AND RANKING

(A location map must accompany this form.)

A. Identifiers:

Community Name (MNHESP: Swain & Kearsley, 2000): ____________________

TNC/NVCS Association Name (Optional): ____________________

Survey Date: ____________________ Today's Date: ____________________

Survey Site Name: ____________________

Surveyor Name(s): ____________________

Best Source (Field survey or secondary source used to complete this form): ____________________

____

Transcriber (MNHESP use only. YY-MM-DD XXX): ____________________

USGS Topo Quad Name: ____________________ Town Name: ____________________

Directions to site: ____________________

____

____

____________________ GPS Point(s) ___ Yes ___ No

B. Community Description:

Vegetation Description (*EODATA*: **Summarize** the vegetation: dominant and/or characteristic species, indicator species, community structure, variants/microhabitat features, unvegetated surface; spatial distribution (i.e., size, number, and separation distance of patches); intact natural processes, geology, hydrology, topography, and soil properties, especially if relevant to the community identification): ____________________

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____________________ Estimated size (acres) ____________________

Physical Description (*GENDESC*: Describe the landscape surrounding the community, including the natural area. Both within and surrounding the community, describe: physical structures and land use practices; natural disturbances; embedded, adjacent, and nearby natural communities including aquatic features; notable landforms; scenic qualities): ____________________

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Is community within a managed conservation area: ________ Managed Area Name: ____________________

Evidence of Disturbance/Threats to the Community/Management Recommendations (*MGMTCOM*: Describe the anthropogenic disturbances that have decreased the quality and viability of the community such as hydrologic alterations (ditching, damming, etc.), logging, mining, livestock grazing, plantations, orchards, structures, trampling, and exotic flora or fauna within and surrounding the community. Discuss threats to the site and management implications.): ____________________

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Protection Comments (*PROTCOM*: Comment on the legal protectability of the site): ____________________

____

____

General Comments (*COMMENTS*: Note the type of sampling done observation point (form 1), releve plot (form 3), plant list, etc.; note any additional field work needed. Comment on questionable identification.): ____________________

____

____

____

____

Owner's Name: ____________________ Telephone: (___)____________________

Address: ____________________

Is Owner: aware of community?__yes __no ___unknown, protecting community?__yes __no __unknown

Owner Comments (*OWNERCOM*: e.g., contact owner prior to visiting the site):____________________

____

C: Community Element Occurrence Ranking: (Refer to community ranking specifications for assistance.)

Community Size Rank: (Compare relative size to other known occurrences, configuration, patchiness)

A – Excellent **B** – Good **C** – Marginal **D** - Poor

Comments: ____________________

Community Condition Rank: (Consider development/maturity (e.g., old growth), abiotic condition, species and physiognomic diversity, ecological processes, abundance of exotic species, internal connectivity, degree of anthropogenic disturbance including fragmentation).

– Excellent **B** – Good **C** – Marginal **D** - Poor

Comments: ____________________

Community Landscape Context Rank: (Consider the size and connectivity of the natural landscape, the position of the community within the landscape, and the landscape condition)

A – Excellent **B** – Good **C** – Marginal **D** - Poor

Comments: ____________________

Community EO Rank: (What are the long-term prospects for continued existence of this occurrence at the indicated level of quality? A summary of all factors listed above. Explain the basis of your ranking: range wide, state wide, or locally.)

A – Excellent **B** – Good **C** – Marginal **D** - Poor

Comments (*EORANKCOM:* Summarize the above and justify the EO Rank assigned): ____________________

____

____

____

Other rare species and/or natural communities observed at this site (T/U = Transcribed/Updated?):

	SPECIES OR COMMUNITY	T/U?		SPECIES OR COMMUNITY	T/U?
1			4		
2			5		
3			6		

Form 3: Quantitative Community Characterization

rev. May, 1998

MA Natural Heritage & Endangered Species Program

A. Identifiers (general EOR information)

Sci. name: 1.SNAME: ______________________ 2.GNAME: ______________________

3.Site name: ______________________ 4.Survey site name: ______________________

5.Quad name(s): __________ 6.Quad code(s): __________ 7.County name(s): __________ 8.County code(s): __________

9.Town (LOCALJURIS): __________ 17.State: ______ 10.Lat: N __________ 11.Long __________ W

12. Directions: ____

____

____

____

13.Sourcecode: __________ 14.Survey date __________ 15.Last obs __________ 16.First obs: __________

18 Surveyors: ____

B. Environmental Description

19.Transect / Observation point #	20.Image annotation #	21.Elevation:
22.Topographic position: ____Interfluve ____Backslope ____High slope ____Step in slope ____High level ____Lowslope ____Midslope ____Toeslope ____Low level ____Channel wall ____Channel bed ____Basin floor ____Other	23.Topographic sketch:	24.Slope degrees:______ 25.Slope aspect:_______ -- 26.Parent material:
27.Soil profile description: note depth, texture, and color of each horizon. Note significant changes such as depth to mottling, depth to water table, root penetration depth (SOILCOM) 28.Organic horizon depth:__________ 29.Organic horizon type:__________ 30.Average pH of mineral soil:__________	31.Soil moisture regime: ____Extremely dry ____Somewhat wet ____Very dry ____Wet ____Dry ____Very wet ____Somewhat moist ____Moist ____Permanently inundated ____Periodically inundated	32.Stoniness: ________Stone free <0.1% ________Moderately stony 0.1-1% ________Stony 3-15% ________Very stony 15-50% ________Exceedingly stony 50-90% ________Stone piles >90%
	33.Soil drainage: ____Rapidly drained ____Somewhat poorly drained ____Well drained ____Poorly drained ____Moderately well drained ____Very poorly drained	34.Average texture: ____ sand ____clay loam ____sandy loam ____ clay ____loam ____ peat ____silt loam ____muck other__________________
	35.Unvegetated surface: ____ % Bedrock ____% Litter, duff ____ % Large rocks (cobbles, boulders > 10 cm) ____ % Wood (> 1 cm) ____ % Small rocks (gravel, 0.2-10 cm) ____ % Water ____ % Sand (0.1-2 mm) ____ % Bare soil ____% Other:______________	
	36.Environmental Comments: vegetation homogeneity, erosion / sedimentation, inundation, etc. 37.Plot representativeness:	

C. Vegetation 38.System: __ Terrestrial __ Palustrine __ Estuarine 39.Plot number:___ 40.Plot dimensions:_____________

41.Leaf type:	42.Leaf phenology:	43.Physiognomic type:		44.	height	% cover
____Broad-leaf	____Deciduous	____Forest	____Woodland	T1 Emergent tree		________
____Semi-broad-leaf	____Semi-deciduous	____Sparse woodland	____Scrub thicket	T2 Tree canopy		________
____Semi-needle-leaf	____Semi-Evergreen	____Shrubland	____Sparse shrubland	T3 Tree sub- canopy		________
____Needle-leaf	____Evergreen	____Dwarf shrubland	____Dwarf scrub thicket	S1 Tall shrub		________
____Graminoid	____Perennial	____Sparse dwarf shrubland		S2 Short shrub		________
____Broad-leaf herbaceous	____Annual	____Herbaceous	____Non-vascular	H Herbaceous		________
____Pteridophyte		____Sparsely vegetated		N Non-vascular		________
				E Epiphyte		________
				V Vine / liana		________

45.Species / percent cover: starting with uppermost stratum, list all species and % cover for each in the stratum. For forests and woodlands, list on a separate line below each tree species the DBH of all trees above 10 cm diameter. Separate the measurements with a comma and note whether in cm or inches.

Field forms were designed to standardize data collection. We have divided the community data into categories, and designed separate forms with different purposes:

COMMUNITY FORM 1: TRANSECT, SITE SURVEY SUMMARY: use this form for reconnaissance, for a new site that is essentially unknown from community description perspective. Use this form to try to "make sense" of the landform: where are the communities in relation to changes in topography? What are the communities? What are the boundaries? For sites that are degraded (obvious C and D ranked community occurrences for which no further activity is planned), this may be the only community form that you will complete. It will serve as a record of the visit and provide some community data, but probably will not be mapped or entered into the database of Priority and Exemplary Communities. Iinformation on low quality community occurrences may be entered into a secondary community database to be tracked for a record of the sites. Form 1 is useful for recording general information along transects, with notes taken when communities change.

FORM 2: NATURAL COMMUNITY SUMMARY AND RANKING form: use to record information on the community location and rank. The natural community will be a part of a property or site: a bog, a hemlock ravine, an isolated stretch of floodplain forest are all communities. Single Form2s may have several plot forms with them. Form 2 is used to assign a rank (element occurrence rank); generally for A or B-ranked occurrences, or best known occurrences (C- or D- ranked common communities for which no pristine examples occur). Explain the basis of your ranking: range wide, state wide, or locally. These ranks are meant to apply state wide: if you are only familiar with the community in part of the state, give it a relative rank, but give your area of comparison. If you are giving it a global rank say so clearly. The assumption is that some protection activity is planned for this occurrence, so contains ownership information and other miscellaneous information that will assist in initiating protection activity. This form will also contain basic information regarding management needs of the community element: burning, exclosures, etc. This form can also be used as a record of subsequent visits, as an update form.

FORM 3, BASIC VEGETATION AND HABITAT INFORMATION: This form is to report plots, usually done in the best occurrences of community types. There can be several Forms 3 for any given community occurrence. This form contains all the basic information fields needed for minimum documentation of community occurrences. The sampling method is the relevé, which appears to be a reasonable compromise between the community "species list" and the more detailed plot techniques (e.g. macro-plots). Relevés are circular, square, or rectangular plots placed in the most representative portion of the community occurrence (but placement within this area should be random). Plots in most cases are not permanently marked (but semi-permanent markers may be used if a return visit is anticipated). Plots may be measured with a tape, but if you are familiar with your pace length, you may simply pace the distance and flag the corners. Identify what size and shape plot were used.

A given community occurrence may have several plots. All the information on Form 3 pertains to the <u>plot</u>. If more than one plot is taken (large community occurrences may require more than one plot), use a new sheet for each plot. Each should be labeled carefully to associate it with other form 3s and with its form 2. Make sure each plot can be identified if the pieces of paper get separated. Each set of forms needs a map associated with it to locate the plots and the community.

Filling out Form 3. Follow these instructions as much as possible. There is a lot of information requested, and you may not be able to supply it all. Soil information is helpful, but requires equipment you may not have with you. Do what you can, balancing information acquisition with time available. General descriptions are very useful.

All forms submitted to NHESP will be photocopied. Interns may transcribe them. You need to be neat and clear. Pencil doesn't photocopy well. Your data is valuable – help us make is useful by being legible!

Form 1 Reconnaissance

A. Identifiers:

1) Site Name - "Official" name. Leave blank if you don't know it.

2**) Survey Site Name** - provisional name assigned by field worker; should represent an identifiable feature on topographic map.

3**) Quad name(s) -** USGS quadrangle map name and scale**.** Note if these are the double or single map(s).

4) Quad code(s) - number assigned by MNHESP. Leave blank if you don't know it.

5) County - appropriate name from topographic map.

6) County Code - assigned by MNHESP, leave blank.

7) Town - appropriate name from topographic map.

8) Directions - from an easily identified road or other location. Include parking information if useful. these should be precise directions in words; attach a map if appropriate

9) Source Code -appropriate code, assigned by MNHESP. Put it and your name on copies of the form before photocopying. The pattern is eight characters with F (for field) 01 (for year), first three letters of your last name then 0X (tie breaker, we assign it). All the records for one year for any one person have the same source code. For example, all Pat Swain's field records for 2001 are F01SWA01. (NOT the same directions as in the NY State instructions).

10) Survey Date - year, month, day. Date of survey

11) State: - use postal codes for the state

12) Surveyors - names and addresses, as appropriate. Each group of surveyors will be assigned different codes

B. Topography:

13) Transect - a sequence number for identifying location.

14) Reconnaissance Diagram - diagrammatic cross section or toposequence showing changes in elevation and corresponding changes in vegetation and soils. Mark each observation point and releve location on the diagram. (Corresponding brief descriptions for each point are given in part C). Use arrow to show compass direction and indicate approximate elevation changes and distance covered in meters. Indicate scale using ruler or stick figure.

C. Vegetation/Habitat Observations:

16) Community name - state or regional vegetation name, if known; provisional name may also be assigned.

17) Additional data - state whether site and/or Form 3 were completed for this observation point.

18) - General Description - briefly describe the community or feature with the physiognomy and three dominant species of each stratum. If form 3 was filled out, omit, and write "see form 3".

Form 2: Natural Community Summary and Ranking:

Always include a copy of the appropriate USGS topographic map with this form, with the community and any transects shown.

1) Community Name - name of the community from the draft classification.

2) TNC/NVCS Association Name – an optional field for those working with the National Classification.

3) Survey Date - Date the field work was done.

4) Today's Date - Date the form is filled out.

5) Survey site name - Provisional name of the site, usually named after a geographic feature.

6) Surveyors name(s) - give the main surveyors name first. Add addresses if appropriate.

7) Best Source – themost complete survey. Leave blank if unknown.

8) Transcriber – leave blank, NHESP use only.

9) USGS Topo Quad Name – name of quad used, say if old single or more recent double map.

10) Town - official town the site is in, not local village

11) Directions to the site - from an easily identified road or other location. Include parking information if useful. Give precise directions in words; attach map if appropriate. Use clear sentences that will be understandable to someone who is unfamiliar with the area and has only your directions to follow. Give distances as closely as possible and use compass directions. Give additional directions to the plot within the site.

12) GPS point(s) – yes or no, and supply if taken.

13) Vegetation Description - formal description of the site with list of key species and community structure.

14) Physical Description - Give a word picture of the area, including a general description of the vegetation and the landscape. Describe the setting for the site, including whether there is surrounding conservation land, highways, or development.

15) Is community within a managed conservatin area: name if possible, also if private, public, and owner.

16) Disturbances/Threats/Management – as described on the form. Generally, threats and evidences of disturbances are from observations while in the field or from information gained from knowledgeable sources. These may lead to management recommendations as appropriate

17) Protection comments - to be filled out if the information is known..

18) General Comments – notes on sampling techniques, other forms filled out, and other information gathered or needed. Note if photographs were taken and are available.

19) Owner information - leave blank if not known

Community Element Occurrence Ranking

These fields are very important, fill out the parts you are comfortable with. Use the comment fields. In the comments field state what the comparisons are to: is this a property, region, state, or range wide assessment? Comment on size, exotics, management possibilities, position in the landscape, ownership or other useful criteria. MNHESP does have draft technical criterea for ranks which will be made available with the 2001 interim draft of the Classification of natural communities.

Form 3 Habitat/Vegetation Description

A. Identifiers:

1) SName - State name of the community type. Provisional name assigned by field worker

2) Gname - Formal name of community type.

3) Site Name - "Official" name. Leave blank if you don't know it.

4) Survey Site Name - provisional name assigned by field worker; should represent an identifiable feature on topographic map.

5) Quad name(s) - USGS quadrangle map name and scale**.** Note if these are the double or single map(s).

6) Quad code(s) - number assigned by MNHESP. Leave blank if you don't know it.

7) County - appropriate name from topographic map.

8) County Code - assigned by MNHESP, leave blank.

9) Town - appropriate name from topographic map.

10) Lat. - latitude in degrees, minutes, and seconds. Do not estimate, NHESP will do unless a GPS is used.

11) Long. - longitude as above in 10).

12) Directions - from an easily identified road or other location. Include parking information if useful. Give precise directions in words; attach map if appropriate. Use clear sentences that will be understandable to someone who is unfamiliar with the area and has only your directions to follow. Give distances as closely as possible and use compass directions. Give additional directions to the plot within the site.

13) Source Code -appropriate code, assigned by MNHESP. Put it and your name on copies of the form before photocopying. The pattern is eight characters with F (for field) 98 (for year), first three letters of your last name then 01 (tie breaker, we assign it). All the records for one year for any one person have the same source code. For example, all Pat Swain's field records from 1998 will be/are F98SWA01. NOT the same directions as in the NY State instructions.

14) Survey Date - year, month, day. Date of survey.

15) Last obs - May be the same as the survey date, but could be an update without data collection.

16) First obs - the first time the site was visited. May be years before, may only be known to the year.

17) State - State where community occurrence is located.

18) Surveyors - names and addresses, as appropriate. List principle surveyor first.

B. Environmental Description (Topography):

19) Reconnaissance ID - observation point number, if indicated on Form 1.

20) Image annotation # - patch identifier if noted on aerial photographs.

21) Elevation - elevation of the plot, in feet or meters, label which.

22) Topographic position - topographic position of the community in the landscape, check off.

23) Topographic sketch. - make a topographical sketch and indicate position of plot. Use arrow to show compass direction and indicate approximate elevation changes in meters.

24) Slope degrees - measure slope using a clinometer or describe: flat, gentle, moderate, somewhat steep, steep, very steep, abrupt, overhanging.

25) Slope Aspect - use a compass and be sure to correct for the magnetic declination. Or describe: flat, variable, N, NE, E, SE, S, SW, W, or NW.

26) Parent Material/Bedrock - note the geologic substrate influencing the plant community (bedrock or surficial materials.)

Igneous Rocks

Granitic (Granite, Schyolite, Syenite, Trachyte)
Dioritic (Diorite, Dacite, Andesite)
Gabbroic (Gabbro, Basalt, Pyroxenite, Peridotite)

26) Parent Material/Bedrock - continued

Sedimentary Rocks
- Conglomerates and Breccias
- Sandstone
- Siltstone
- Shale
- Limestone and Dolomite
- Marl
- Gypsum

Metamorphic Rocks
- Gneiss
- Schist
- Slate and Phyllite
- Marble
- Serpentine

Glacial deposits:
- undifferentiated glacial deposit
- till
- moraine
- bedrock and till
- Glacio-fluvial deposits (outwash plains, ice-contacted GF deposits, eskers, kames, pro-glacial deltas, etc.)
- Deltaic deposits (alluvial cones, deltaic complexes)
- Lacustrine and fluvial deposits (glacio-fluvial, fluvio-lacustrine, freshwater sandy beaches, stony/gravelly shore)
- Marine deposits (bars, spits, sandy beaches, old shorelines, old beach ridges, old marine clays, etc.)
- Organic deposits:
  - Peat (with clear fibric structure)
  - Muck
  - Marsh, regularly flooded by lake or river (high mineral content)
- Slope and modified deposits:
- talus and scree slopes
- colluvial
- solifluction, landslide

Aeolian deposits:
- dunes
- aeolian sand flats
- loess deposits
- cover sands

27) Soil Profile Description - Using a shovel with a long narrow blade or a soil auger, dig a pit 2-3 feet deep and note depth, texture, and color (Munsell color chart) of each horizon. Sketch the soil profile representative of the plot. In the sketch indicate depth scale (cm) on left side of profile, horizon designation on right side, boundary characteristics in drawing, and additional information on texture, structure, color, etc. as appropriate.

Simplified Key to Texture (Brewer & McCann, 1982)

A1 Soil does not remain in a ball when squeezed. . . . . . . **sand**
A2 Soil remains in a ball when squeezed. . . . . .B
B Squeeze the ball between your thumb and forefinger, attempting to make a ribbon that you push up over your finger. B1 Soil makes no ribbon. . . . . **loamy sand**
B2 Soil makes a ribbon; may be very short. C
C1 Ribbon extends less than 1 inch before breaking . . . . . . .D
C2 Ribbon extends 1 inch or more before breaking . . . . .E
D1 Add excess water to small amount of soil; soil feels at least slightly gritty . . . . **loam or sandy loam**
D2 Soil feels smooth . . . .**silt loam**
E1 Soil makes a ribbon that breaks when 1-2 inches long; cracks if bent into a ring . . . . F
E2 Soil makes a ribbon 2+ inches long; doesn't crack when bent into a ring . . . . .G
F1 Add excess water to small amount of soil; soil feels at least slightly gritty. . . . .**sandy clay loam or clay loam**
F2 Soil feels smooth . . . . **silty clay loam or silt**
G1 Add excess water to a small amount of soil; soil feels at least slightly gritty . . . . **sandy clay or clay**
G2 Soil feels smooth. . . . . **silty clay**

VON POST SCALE OF PEAT DECOMPOSITION

H1: Completely undecomposed peat; only clear water can be squeezed out.
H2: Almost undecomposed and mud-free peat; water that is squeezed out is almost clear and colorless.
H3: Very little decomposed and very slightly muddy peat; when squeezed water is obviously muddy but no peat passes through fingers. Residue retains structure of peat.
H4: Poorly decomposed and somewhat muddy peat; when squeezed, water is muddy. Residue muddy but it clearly shows growth structure of peat.
H5: Somewhat decomposed, rather muddy peat; growth structure visible but somewhat indistinct; when squeezed some peat passes through fingers but mostly very muddy water. Press residue muddy.

H6: Somewhat decomposed, rather muddy peat; growth structure indistinct; less than 1/2 of peat passes through fingers when squeezed. Residue very muddy, but growth structure more obvious than in unpressed peat.
H7: Rather well-decomposed, very muddy peat; growth structure visible, about 1/2 of peat squeezed through fingers. If water is squeezed out, it is porridge-like.
H8: Well-decomposed peat; growth structure very indistinct; about 2/3 of peat passes through fingers when pressed, and sometimes a somewhat porridge-like liquid. Residue consist mainly of roots and resistant fibers.
H9: Almost completely decomposed and mud-like peat; almost no growth structure visible. Almost all peat passes through fingers as a homogeneous porridge if pressed.
H10: Completely decomposed and muddy peat; no growth structure visible; entire peat mass can be squeezed through fingers.

28) Organic horizon depth - Indicate depth to contact with mineral soil or mixture of organic and mineral soil (O horizon)

29) Organic horizon type -

MOR - acid reaction. lacking in microbial activity except fungi, and composed of several layers of organic matter in varying degrees of decomposition.

MULL - chemically neutral or alkaline reaction; well aerated, and provides generally favorable conditions for decomposition of organic matter. Well decomposed and intimately mixed with mineral matter.

30) - Average pH of mineral soil - measure pH of mineral soil.

31) Moisture Regime - while soil drainage is based on soil morphology only, moisture regime is based on the amount of water available to plants. It is evaluated on the basis of soil drainage, soil structure and texture, and climate. Thus, a well-drained till is much more moist than a well-drained coarse textured glacio-fluvial deposit within the same area, or a well-drained sandy loam in a humid climate is moister than the same soil in a climatically dry region.

EXTREMELY DRY: steep eroding sands, rock piles, gravel.

VERY DRY: medium and coarse sands: shallow soils, not influenced by ground water.

DRY: deep silty sands and loamy sands, not influenced by ground water.

WELL-DRAINED: deep sandy loams and loams, not influenced by ground water.

SOMEWHAT MOIST: loams and sandy loams with some rust mottling in lower part of B or C horizon. Moist variants or zonal soil types.

MOIST: soil surface above the maximum water level; normal soil profile development hampered because of imperfect drainage. Upper 1-2 feet of soil well-aerated during vegetative season. On mineral soils a severely

mottled to homogeneous brown horizon (color B) is present. Occurs also on heavy textured soils with perched water table and on dry deep peat.

SOMEWHAT WET: maximum water level at or close to the soil surface. Anaerobic soils; on mineral soils reduced, grey soil matrix with rust mottling. Gleysols, some peat soils.

WET: water level at soil surface for most of vegetative season. Reduced gley layer up to mineral soil surface on mineral soils; mottling usually absent or insignificant. Organic soil, gleysol

VERY WET: water level above soil surface for most part of vegetative season. Minimum water level approximately at soil surface. Organic soil.

PERMANENTLY INUNDATED: (hydric) minimum water level above soil surface, soils permanently inundated.

PERIODICALLY INUNDATED: (hydric) known to be periodically inundated due to flood/drought cycles or other variable moisture regimes.

32) Stoniness - average stoniness of deposit up to 1 m in depth, check off..

33) Soil Drainage - The soil drainage classes are defined in terms of (1) actual moisture content (in excess of field moisture capacity), and (2) the extent of the period during which excess water is present in the plant-root zone.

It is recognized that permeability, level of groundwater, and seepage are factors affecting moisture status. However, because these are not easily observed or measured in the field, they cannot be used generally as criteria of moisture status. It is further recognized that soil profile morphology, for example mottling, normally, but not always, reflects soil moisture status. Although soil morphology may be a valuable field indication of moisture status, it should not be the overriding criterion. Soil drainage classes cannot be based solely on the presence or absence of mottling. Topographic position and vegetation as well as soil morphology are useful field criteria for assessing soil moisture status.

RAPIDLY DRAINED - The soil moisture content seldom exceeds field capacity in any horizon except immediately after water addition. Soils are free from any evidence of gleying throughout the profile. Rapidly drained soils are commonly coarse textured or soils on steep slopes.

WELL DRAINED - The soil moisture content does not normally exceed field capacity in any horizon (except possibly the C) for a significant part of the year. Soils are usually free from mottling in the upper 3 feet, but may be mottled below this depth. B horizons, if present, are reddish, brownish, or yellowish.

MODERATELY WELL DRAINED - The soil moisture in excess of field capacity remains for a small but significant period of the year. are commonly mottled in the lower B and C horizons or below a depth of 2 feet. The Ae horizon, if present, may be faintly mottled in fine-textured soils and in medium-textured soils that have a slowly permeable layer below the solum. In grassland soils the B and C horizons may be only faintly mottled and the A horizon may be relatively thick and dark. excess of field capacity remains in subsurface horizons for moderately long periods during the year. are commonly mottled in the B and C horizons; the Ae horizon, if present, may be mottled. The matrix generally has a lower chroma than in the well-drained soil on similar parent material.

SOMEWHAT POORLY DRAINED - The soil moisture in excess of field capacity remains in subsurface horizons for moderately long periods during the year. Soils are commonly mottled in the B and C horizons; the Ae horizon, if present, may be mottled. The matrix generally has a lower chroma than in the well-drained soil on similar parent material.

POORLY DRAINED - The soil moisture in excess of field capacity remains in all horizons for a large part of the year. The soils are usually very strongly gleyed. Except in high-chroma parent materials the B, if present, and upper C horizons usually have matrix colors of low chroma. Faint mottling may occur throughout.

VERY POORLY DRAINED - Free water remains at or within 12 inches of the surface most of the year. The soils are usually very strongly gleyed. Subsurface horizons usually are of low chroma and yellowish to bluish hues. Mottling may be present but at depth in the profile. Very poorly drained soils usually have a mucky or peaty surface horizon.

34) Average Texture - overall texture of upper 1 m of loose deposit. Given in #27.

MUCK: Dark colored, finely divided, well decomposed organic soil material mixed with mineral soil material. The content of organic matter is more than 20%.

PEAT: Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture.
For Peat deposits use Von Post scale of peat decomposition given in #27.

35) Unvegetated surface - Percentage of surface covered by each category, only including items covering more than 5%.

36) Environmental comments - Additional observations about the plot. Note whether vegetation is homogeneous or made up of distinct units (e.g. hummocks and hollows); evidence of erosion or sedimentation; further observations on inundation, etc.

37) Plot representativeness - Does this plot represent the full variability of the community occurrence? In not, were additional plots done: Note additional species not in plot (use back in separate area if necessary).

C. Environmental Description (Vegetation): (Back of form)

ADD Community Name -. vegetation type name used in state classification.

Plot number, for correlating with site forms and other plots.

Give Plot dimensions used: width and length dimensions for rectangular (or square) plots or radius for circular plots. Choose the appropriate plot size based on the appropriate vegetation. Mueller-Dombois and Ellenberg, 1974, (Source: D. Mueller-Dombois and H. Ellenberg. 1974. Aims and Methods of Vegetation Ecology. John Wiley and Sons. NY.) recommend:

Forest	200 - 500 m^2	Dwarf-shrub heath:	10 -25 m^2
Shrubland	50 - 200 m^2	Moss communities	1 - 4 m^2
Grassland	50 - 200 m^2	Lichen communities	0.1 - 1 m^2

Square, short rectangular, or circular plots are preferred whenever feasible. Because there is a greater potential for edge effects or patchiness in long rectangular plots, use them only when needed to fit in a narrow zone.

41) Leaf type - Select one which best describes the leaf form of the tallest stratum with at least 25% cover..

42) Leaf phenology - Select the type of leaf structure for the dominant stratum with greater then 25% cover.

Perennial - is herbaceous vegetation composed of more than 50% perennial species.
Annual - Herbaceous vegetation composed of more than 50% annual species.

43) Physiognomic type -Select the description that best describes the community structure..

44) Strata / life forms - Visually divide the community into vegetation layers. Indicate the height of the stratum in the first column, and average percent cover of the whole stratum in the second column.

45) Releve Data - list all species and their abundance/cover classes for each stratum, beginning with the tallest. Separate each stratum with a blank line. On the first line of each stratum, record the stratum code (OR Kuchler code), with its total percent cover. Species outside the plot should be listed in parentheses and not counted in the total number of species used in tabular comparison. For tree strata, include diameters (DBH) of several (or all, say which) of the (largest) trees in the plot. IF YOU USE A DIFFERENT APPROACH, MAKE IT VERY CLEAR WHAT YOU HAVE DONE.

Braun-Blanquet

Cover/abundance values:
r one or few individuals
+ occasional, < 5% cover
1 common, < 5% cover
2- 5-12% cover
2+ 13-25% cover
3 26-50% cover
4 51-75% cover
5 > 75% cover

Sociability scale:
1 growing solitarily, singly
2 small groups, small tussocks
3 small patches, large tussocks
4 large patches, mats
5 great crowds, mats covering whole plot

Kuchler Height Classes

an alternative to the protocol on the back of form 3

Life form Categories

Woody Plants
B Broadleaf evergreen
D Broadleaf deciduous
E Needleleaf evergreen
N Needlaleaf deciduous
S Semideciduous (B+D)
M Mixed (D+E)

Herbaceous Plants
G Graminoids
H Forbs
L Lichens, mosses

Special Life Forms
C Climbers (lianas)
X Epiphytes

Structural Categories

Height (stratification)
8 >35m
7 20 - 35m
6 10 -20m
5 5 - 10m
4 2 - 5m
3 0..5 - 2m
2 0.1- 0.5m (knee high)
1 <0.1m (ankle high)

Coverage (of the layer)
c continuous (>75%)
i interrupted (50 - 75%)
p parklike, patches (25 - 50%)
r rare (5 - 25%)
b barely present, sporadic (1-5%)
a almost absent, scarce, (<1%)

Protocol for Community forms (form 3, back)
January 19, 1996, P. Swain
Using relevé procedures.

Plot sizes vary with the community--generally 20 x 20m or 10 x10m for forest. If necessary subplots can be nested for different layers (5x5m for shrubs, several 1x1m for herbaceous)--label clearly whatever is done.
NOTE: TNC recommends using actual estimated coverages instead of cover classes. If doing that be consistent, and clearly explain what you have done.

Kuchler height class

Species name1	Braun-Blanquet's code	notes (cover . sociability)
Species name2	Braun-Blanquet's code	notes (cover . sociability)

for example: (some people use abbreviations for species in notes, Acsa or Quru
D6c

Acer saccharum	3.1	dbh to 10"
Quercus rubra	1.1	dbh to 8"
Acer rubrum	+.1	dbh to 6"
Fraxinus americana	1.1	dbh to 8", one dead stem

M5p

Tsuga canadensis	2.2
Sassafras albidum	+.1
Betula papyrifera	+.2
Cornus ammomum	1.2
Viburnum lentago	+.1

H2-3c (There's a choice here--call entire layer H and list small Ds and Gs, or separate each growth form. Purists probably separate. I tend to name the layer by appearance, so if grassy looking its G, even if has Hs or if broadleafed herb-y looking its H but includes woody and grassy. Tends to be a long section.)

Aster infirmus +.1 (fl) (There are <u>Lots</u> of +.1, s, probably most common.)
Aster paternus +.2
Viola sp 1.2 (it is best to be as precise as possible on species for the computer)
Eupatorium rugosum +.1
Geum canadense +.1
Osmunda cinnamomea +.2
Acer rubrum +.1
Vaccinium angustifolium 2.4
(Carex stricta 3.4, area near woods, not in plot)

B1r

Mitchella repens	+.2
Gaultheria procumbens	+.2

Note: There's flexibility here. Lump overlapping size classes (ie. D4-5r).
If its a measured plot, say so: if eye balled, say where. And so on.

Natural Heritage & Endangered Species Program
MA Division of Fisheries & Wildlife
North Drive, Westborough, MA 01581
(508) 792-7270 x 200

RARE ANIMAL OBSERVATION FORM

1. OBSERVER INFORMATION
a) Observer's Name, Address, Phone:

b) Date and Time of Observation:

c) Species Observed:

2. LOCATIONAL INFORMATION
Please describe where this rare species observation was made.

a) Town:
County:
USGS Topo:

b) Please attach a photo copy of the appropriate section of a USGS topo map (or similar map if a topo map is unavailable). Please carefully mark the site in red where you observed this rare species.

c) Please explain in writing how to get to this spot:

3. POPULATION INFORMATION
Please describe what you observed.

a) Number of animals observed:

b) Age and sex of animals observed:

c) Evidence (if any) of breeding activity at this site:

d) Have you observed this species at this site in previous years?
If yes, please give details:

SITE INFORMATION
a) Description of habitat at this site:

b) Observed or potential threats to the species or its habitat at this site:

c) Landowner's name and address, if known:

SPECIES IDENTIFICATION
a) Was a positive ID possible?
Based on what field marks?

b) Were photographs or slides taken?
If yes, please submit a clear photograph or slide of the animal.

c) Qualifications of observer (check all that apply):
___Amateur naturalist - Years of experience ____
___Conservation Commission member
___Biology/science teacher
___Environmental Consultant
___Degree in Biology - Bachelor's___ Master's___ Ph.D.___
___Other - Please specify_________________________________

d) Briefly explain your previous field experience with this species:

e) List names and qualifications of other observers (if any):

ADDITIONAL COMMENTS (if any):

CERTIFICATION:

I hereby certify under pains and penalties of perjury that the information contained in this report is true and complete to the best of my knowledge.

Signature:

Date:

Please submit field forms and all supporting documentation (USGS map, photo, etc.) to:

Natural Heritage and Endangered
Species Program
MA Division of Fisheries & Wildlife
North Drive
Westborough, MA 01581
(508) 792-7270 ext. 200

Thank you for contributing to the Natural Heritage & Endangered Species Program database. Your efforts are valuable and appreciated.

Natural Heritage & Endangered Species Program
MA Division of Fisheries & Widllife
North Drive, Westborough, MA 01581
(508) 792-7270 x 165

RARE PLANT OBSERVATION FORM

OBSERVER INFORMATION
Observer's Name, Address, and Phone:

Species Scientific Name:

NHESP Element Occurrence Number (if known):

Observation Date:

Today's Date:

LOCATIONAL INFORMATION
a) USGS Quad Name and Series (7.5"x7.5" or 7.5"x15"):
County:
Town:

b) Directions to location of observations (please attach USGS map):

c) Habitat: (plant communities, associated vegetation, physical characteristics, geological features, surrounding land use. Are other rare species present?)

POPULATION INFORMATION:

Population found? (Y/N):

If No, is population presumed extirpated and why?

If Yes,
Number of mature plants:
Number of immature plants:
Number of plants age unknown:

Population area (give unit of measurement):

Percent of population:
in leaf:

in bud:
in flower:
with immature fruit:
mature fruit:
senescent:

Observations of floral visitors, fruit dispersers:

Vigor of individuals and population:

Evidence of expansion or decline:

Have you observed this species at this site in previous years?
Please give details:

SITE PHYSIOGRAPHY
Elevation:

Topographic position (crest, upper slope, mid slope, lower slope, bottom?):

Aspect (north, south, east, west, flat?):

Slope (0-20 degrees, 20-45 degrees, 45-75 degrees, vertical?):

Light (open, filtered, shade?):

Moisture (inundated, wet, mesic, dry, xeric?):

Soil types:

Surficial rock types (with percent of ground covered):

Bedrock/parent material:

Surficial water (distance away and source):

MANAGEMENT/OWNERSHIP:

MNHESP Site Name (if any):

Managed Area (if any):

Comments/Management recommendations:

Disturbance or threats (natural or unnatural) to population:

Land Owner's Name, Address, and Phone:

Ownership Comments:

ELEMENT OCCURRENCE (EO) SUMMARY
(Circle one choice in each category)

EO Quality
How representative is this occurrence? Consider the size and productivity of the population and the vitality and vigor of the individuals.

A - Excellent B - Good C - Marginal D - Poor

Comments:

EO Condition
Is the habitat supporting the EO pristine or degraded? Is there a potential for the habitat to recover from disturbances?

A - Excellent B - Good C - Marginal D - Poor

Comments:

EO Viability
What are the long-term prospects for continued existence of this occurrence at the indicated level of quality?

A - Excellent B - Good C - Marginal D - Poor

Comments:

EO Defensibility
Can this occurrence be protected from extrinsic human factors?

A - Excellent B - Good C - Marginal D - Poor

Comments:

EO RANK
A summary of all factors listed above.

A - Excellent B - Good C - Marginal D - Poor

Comments:

ADDITIONAL COMMENTS (if any)

CERTIFICATION
I hereby certify under pains and penalties of perjury that the information contained in this report is true and complete to the best of my knowledge.

Signature:

Date:

Please submit form, a copy of a USGS topo map showing plant location, and all supporting documentation to the State Botanist at:

Massachusetts Natural Heritage & Endangered Species Program
Division of Fisheries & Wildlife
North Drive
Westborough, MA 01581
(508) 792-7270 ext 200

Thank you for contributing to the Natural Heritage & Endangered Species Program database. Your efforts are valuable and appreciated.

Natural Heritage & Endangered Species Program

Route 135
Westborough, MA 01581
Phone: 508/792-7270 ext. 200
Fax: 508/792-7275
http://www.state.ma.us/dfwele

Vernal Pool Fact Sheet

What are Vernal Pools?

Vernal pools are temporary bodies of fresh water that provide critical habitat for many vertebrate and invertebrate wildlife species. "Vernal" means spring, and indeed, many vernal pools are filled by spring rains and snowmelt, only to dry up during the hot, dry months of summer. However, many vernal pools are filled by the rains of autumn and may persist throughout the winter. Vernal pools are quite often very small and shallow; vernal pools that support rich communities of vertebrate and invertebrate animals may measure only a few yards across. However, vernal pools of several acres occur throughout Massachusetts.

Where are Vernal Pools Found?

Vernal pools are common in Massachusetts, probably occurring in every town in the state. Vernal pools are found across the landscape where small woodland depressions, swales or kettle holes collect spring runoff or intercept seasonally high groundwater tables. Although many people associate vernal pools only with upland wooded areas, valuable vernal pools also occur in meadows, river floodplains, interdunal swales, and large vegetated wetland complexes. Vernal pool habitat occurs wherever water is contained for more than 2 months in the spring and summer of most years, where no fish are present.

Why are Vernal Pools Valuable?

Vernal pools constitute a unique and increasingly vulnerable type of wetland. Vernal pools are inhabited by many species of wildlife, some of which are totally dependent on vernal pools for their survival. Vernal pools do not support fish because they dry out annually or at least periodically. Some may contain water year round, but are free of fish as a result of significant draw-downs that result in extremely low dissolved oxygen levels. The wood frog (*Rana sylvatica*), the eastern spadefoot toad (*Scaphiopus h. holbrooki*), and the four local species of mole salamander (*Ambystoma* spp.) have evolved breeding strategies intolerant of fish predation on their eggs and larvae; the lack of fish populations is essential to the breeding success of these species. Other amphibian species, including the American toad (*Bufo americanus*), green frog (*Rana clamitans*), and the red-spotted newt (*Notophthalmus viridescens*), often exploit the fish-free waters of vernal pools but do not depend on them. Vernal pools also support rich and diverse invertebrate fauna. Some invertebrate species, such as fairy shrimp (*Eubranchipus* spp.), are also entirely dependent upon vernal pool habitat. Invertebrates are both important predators and prey in vernal pool ecosystems. Vernal pools are an important habitat resource for many birds, mammals, reptiles and amphibians, including many state-listed rare species.

State-listed species found in vernal pools

Species	Status
Blue-spotted salamander (*Ambystoma laterale*)[1]	SC
Jefferson salamander (*Ambystoma jeffersonianum*)[1]	SC
Marbled salamander (*Ambystoma opacum*)[1]	T
Four-toed salamander (*Hemidactylium scutatum*)[2]	SC
Eastern spadefoot toad (*Scaphiopus holbrooki*)[1]	T
Spotted turtle (*Clemmys guttata*)[2]	SC
Wood turtle (*Clemmys insculpta*)[2]	SC
Blanding's turtle (*Emydoidea blandingi*)[2]	T

[1] Obligate species require vernal pool habitat to successfully breed
[2] Facultative species may use vernal pools but do not require them
[3]. Status pursuant to the MA Endangered Species Act; T: Threatened, SC: Special Concern

VERNAL POOL PROTECTION

The Massachusetts Wetlands Protection Act Regulations (310 CMR 10.00), the Massachusetts Surface Water Quality Standards (314 CMR 4.00) used to administer section 401 of the federal Clean Water Act, the Massachusetts Environmental Code: Title 5, and the Forest Cutting Practices Act regulations all provide protection to vernal pools that have been officially certified. The regulations for both the Wetlands Protection Act and Forest Cutting Practices Act also provide protection to vernal pools that have not been certified if their occurrence is adequately documented during permit review. Protection under any of these laws requires the following:

1) the vernal pool occurs in an area subject to the jurisdiction of the regulations; and
2) the activities proposed are regulated.

The Massachusetts Wetlands Protection Act regulations (310 CMR 10.00) protect certified vernal pools and up *to* 100 feet beyond the boundary of the pool (referred to as the "vernal pool habitat"), by preventing alterations which would result in the reduction of the wildlife habitat value of the certified vernal pool. A certified vernal pool is not automatically protected by these regulations, though. Certified vernal pools must occur within a resource area that comes under the jurisdiction of the Act before they receive protection. Similarly, the 100 feet around the vernal pool must also fall within a resource area, and not in non-jurisdictional upland or the buffer zone of a resource area in order to be protected under the Act. The March, 1996 Massachusetts Department of Environmental Protection Wetlands Report Alert established a desire within the DEP to protect vernal pools that occur within any jurisdictional wetlands. Although performance standards exist only for vernal pools that occur within *Land Subject to Flooding*, vernal pools occurring within any wetlands resource area should be protected through the incorporation of appropriate conditions in an Order of Conditions issued by a conservation commission or the DEP.

Vernal pools that are not certified may also be protected by a local conservation commission or the DEP if credible scientific evidence is presented up until the end of the appeals period for a Superseding Order of Conditions issued by the DEP. A conservation commission, or the DEP on appeal, can incorporate protective conditions into an Order of Conditions that would prevent the alteration of the wildlife habitat value of the pool and it's 100 foot "vernal pool habitat" if they occur within a regulated wetland even though it is not certified.

Each DEP Regional Office has at least one Vernal Pool Liaison who should be contacted for all questions related to the protection of both certified and uncertified vernal pools. Since regulatory authority rests with the Department, they are best able to answer questions about what may or may not happen in or around vernal pools. Your regional liaison may be reached at the following addresses:

Northeast Regional Office
203-A Lowell Street
Wilmington, MA 0l887

Southeast Regional Office
20 Riverside Drive
Lakeville, MA 02347

Central Regional Office
627 Main Street
Worcester, MA 01608

Western Regional Office
State House West, 4th Floor
Springfield, MA 01103

The Massachusetts Surface Water Quality Standards (314 CMR 4.00) administer Section 40l of the federal Clean Water Act and protect certified vernal pools. Under these regulations, any certified vernal pool is classified as an Outstanding Resource Water (ORW). The regulations, administered by the DEP, strictly prohibit discharges of solid or liquid fill within certified vernal pools. Storm drainage from roads and rooftops as well as solid fill are prohibited within the boundaries of the pool. As is the case with the Wetlands Protection Act however, the certified vernal pool as well as the proposed activity must be within the jurisdiction of these regulations - the state's Clean Water Act - before it receives this protection.

Vernal Pool Protection continued

The Massachusetts Environmental Title 5 (310 CMR 15.000) regulates the siting and construction of subsurface sewage disposal (septic) systems in the state. A system's septic tank and distribution box must be located a minimum of 50 feet, and the leaching field a minimum of 100 feet, from the boundary of a certified vernal pool.

The Massachusetts Forest Cutting Practices Act Regulations (3.04 CMR 11.00) protect certified vernal pools from certain forestry impacts. Harvesting requirements limit cutting to no more than 50% of the trees within 50 feet of a certified vernal pool. They also require that trees or tree tops not be felled in certified vernal pools, and restrict the use of pools as staging areas or skidder trails. Guidelines, similar to the regulations, are established for activities planned near uncertified vernal pools identified by consulting foresters.

The Vernal Pool Boundary

When a vernal pool has been certified and the local conservation commission or the state Department of Environmental Protection has determined that it is protectable, the boundary of the vernal pool may require delineation.

The extreme edges of vernal pool habitat represent one of the most ecologically valuable portions of these habitats. Shallow water at the edges of a pool is generally the first to thaw in the spring. This provides early access to the pool for the earliest breeding species. The shallow water zones also tend to be significantly warmer than the deeper portions of a vernal pool throughout the spring. Egg masses of early breeding amphibians benefit from the warmer water temperatures at the pool edges that promote rapid egg development.

The ecological boundary of vernal pool habitat is therefore defined as

> the <u>lower</u> of:
>
> a) the maximum elevation of a topographic depression that holds water for a minimum of 2 continuous months; or
>
> b) the maximum observed or recorded water level in a topographic depression

PLEASE NOTE The boundary of vernal pool habitat may be defined differently for the purpose of state or federal protection.

The boundary of a certified vernal pool is not established when a certification number is issued. Field observations of maximum flood levels or of indicators of the maximum water level obtained must be made to deter-mine the boundary. Therefore, in recording observations of vernal pools for the purpose of certification, notes pertaining to observed water level and recognizable landmarks that show maximum flooding are extremely helpful in boundary delineation.

The Wetlands Protection Act regulations allows a project proponent to submit an opinion as to the extent of a certified vernal pool that is based upon a theoretical one year storm of a total of 2.7 inches of water in 24 hours. If an opinion based on this theoretical storm event is to be submitted, it should take into account ground water that the basin is holding at the beginning of the spring amphibian breeding season. The DEP has stated in its program policies that ground water inputs should not be ignored in these calculations because it will result in a total volume that may be considerably smaller than the basin holds in any given spring.

How Can Vernal Pools be Certified?

The Massachusetts Natural Heritage & Endangered Species Program administers the official vernal pool certification program. The Certification Program depends entirely on volunteer effort and the initiative of interested individuals and organizations Interested parties should locate potential vernal pools and then:

1. Contact the Massachusetts Natural Heritage & Endangered Species Program [(508) 792-7270, ext.200] to obtain the official "Guidelines for the Certification of Vernal Pool Habitat," along with Vernal Pool Field Observation Forms;

   Certification is based on proof that a confined basin depression provides important wildlife habitat consistent with the vernal pool certification criteria in the "Guidelines". Animals that use vernal pools at some point in their life cycle are generally divided into two groups:

   Obligate Species: those vertebrate and invertebrate species that rely on vernal pools for all or a portion of their life cycle and are unable to successfully complete their life cycle without vernal pools

   Facultative Species: those vertebrate and invertebrate species that can use vernal pool habitat for all or a portion of their life cycle, but are able to successfully complete their life cycle in other water bodies

   Obligate species serve as *direct* indicators of vernal pool habitat because they require at least two months of flooded conditions and the absence of established fish populations. When breeding evidence of obligate species is documented, it is not necessary to prove that an established, reproducing fish population does not exist. Facultative species serve as *indirect* indicators of vernal pool habitat. Therefore, if only facultative species are observed, evidence that there is no reproducing fish population must also be submitted for certification.

2. Fill out and submit a Field Observation Form along with photographic documentation of the physical and biological criteria required by the "Guidelines" and required maps to the NHESP for review. Photographs (slides or prints) are the preferred type of documentation of the biological certification criteria observed in a vernal pool. The most easily photographed evidence of vernal pool indicator species is egg masses of wood frogs and mole salamanders. These are conspicuous in the early spring and easily distinguished from other amphibian eggs. See the "Guidelines" for details.

Following receipt of certification materials, the Natural Heritage & Endangered Species Program assesses the completeness and accuracy of the information and documentation submitted. The NHESP does not field visit pools prior to certification but relies on the presentation of accurate and clear documentation.

After it is determined that a vernal pool meets the physical and biological criteria established in the "Guidelines," it will be officially certified by the NHESP. The observer, local conservation commission, regional office of the Department of Environmental Protection and the landowner are notified of the certification. The locations of Certified Vernal Pools are plotted on the NHESP's "Estimated Habitats of Rare Wetlands Wildlife and Certified Vernal Pools" on a biennial basis. These maps are sent to the town clerk and to the Conservation Commission, and are available for viewing by the public. The NHESP also produces a statewide Atlas of these maps, reproduced at a reduced scale, which is available at cost.

Commonwealth of Massachusetts

Division of Fisheries & Wildlife

Wayne F. MacCallum, *Director*

Spring 2000

CERTIFICATION CRITERIA

Please read and understand the DOCUMENTATION REQUIREMENTS in the next section before submitting vernal pool certification applications.

Documentation of the biological and physical criteria described in this section is necessary to obtain official certification of any vernal pool.

DOCUMENTATION OF ANY ONE OF THE FOLLOWING (1-3) WILL CONFIRM THE EXISTENCE OF VERNAL POOL HABITAT AND IS SUFFICIENT FOR OFFICIAL CERTIFICATION

1) The Obligate Species Method
2) The Facultative Species Method
3) The Dry Pool Method

1) The Obligate Species Method

Evidence of a confined basin depression with no permanently flowing outlet **AND** one or more of the following:

1A Breeding* Obligate Amphibian

Wood frog (*Rana sylvatica*)
Spotted salamander (*Ambystoma maculatum*)
Blue-spotted salamander (*Ambystoma laterale*)**
Jefferson salamander (*Ambystoma jeffersonianum*)**
Marbled salamander (*Ambystoma opacum*)**
Eastern spadefoot toad (*Scaphiopus holbrooki*)**

OR

1B Adult Obligate Invertebrate

Fairy shrimp (ANOSTRACA: *Eubranchipus*)

* Acceptable Breeding Evidence

Documentation of **any one** of the following proves that an area functions as vernal pool habitat. For the purposes of official certification, if amphibian evidence is submitted it must show evidence of breeding.

1. Breeding Adults
   - Frogs and toads: breeding chorus and/or mated pairs
   - Salamanders: courting individuals (congressing) and/or spermatophores

2. Egg Masses (**two or more are required**)
3. Larvae (tadpoles or salamander larvae)
4. Transforming Juveniles
   - Frogs and toads: tail remnants evident
   - Salamanders: gill remnants evident

**** State-listed Species**

State-listed Endangered (E), Threatened (T) and Special Concern (SC) species are protected under the Massachusetts Endangered Species Act (321 CMR 10.60); fill out a Rare Animal Observation Form and submit along with Certification Form.

CERTIFICATION CRITERIA

2) The Facultative Species Method

Evidence of a confined basin depression with no <u>permanently</u> flowing outlet **AND** evidence that there is no established, reproducing fish population

AND photographs of <u>two or more</u> of the following:

AMPHIBIANS

Breeding* Spring peeper (*Pseudacris crucifer*)
Breeding* Gray treefrog (*Hyla versicolor*)
Breeding* American toad (*Bufo americanus*)
Breeding* Fowler's toad (*Bufo woodhousii*)
Breeding* Green frog (*Rana clamitans melanota*)
Breeding* Pickerel frog (*Rana palustris*)
Breeding* Leopard frog (*Rana pipiens*)
Breeding* Four-toed salamander (*Hemidactylium scutatum*)**
Adult or Breeding* Red-spotted Newt (*Notophthalmus v. viridescens*)

REPTILES

Spotted turtle (*Clemmys guttata*)**
Blanding's turtle (*Emydoidea blandingii*)**
Wood turtle (*Clemmys insculpta*)**
Painted turtle (*Chrysemys p. pictata*)
Snapping turtle (*Chelydra serpentina*)

INVERTEBRATES

Predaceous diving beetle larvae (*Dytiscidae*)
Water scorpion (*Nepidae*)
Dragonfly larvae (*Odonata: Anisoptera*)
Damselfly larvae (*Odonata: Zygoptera*)
Dobsonfly larvae (*Corydalidae*)
Whirligig beetle larvae (*Gyrinidae*)
Caddisfly larvae (*Trichoptera*)
Leeches (*Hirundinea*)
Freshwater (fingernail) clams (*Pisidiidae*)
Amphibious, air-breathing snails (*Basommatophora*)

3) The Dry Pool Method

Evidence of a confined basin depression containing no standing water (dry pool)

AND one or more of the following:

Cases of caddisfly larvae (*Trichoptera*)
Adults, juveniles or shells of either of the following:
  Freshwater clams (*Pisidiidae*)
  Amphibious, air-breathing snails (*Basommatophora*)
Shed skins (exuvia) of dragonfly or damselfly larvae on vegetation along the edge of pool

DOCUMENTATION REQUIREMENTS

Documentation of the biological and physical characteristics listed in the CERTIFICATION CRITERIA must be submitted for official certification of a vernal pool. Photographic prints or slides are the preferred method of documentation, but video tapes of evidence or audio recordings of calling frogs are acceptable. Field notes are encouraged, but are not accepted as evidence; they must be submitted along with photographic or taped documentation.

> Label all photographs as follows:
>
> **Location of pool**
> **(or tracking number)**
> **Date of photograph**
> **Observer's name**

The following field observations must be adequately documented

1. Biological criteria:
   1A Clear photographs or video of obligate amphibian breeding evidence
   OR
   1B Clear photographs or video of facultative invertebrate or vertebrate species (**AND** 2B or 2C)
   OR
   1C Audio tape of frog breeding chorus

2. Fishlessness:
   2A Evidence of obligate species per CERTIFICATION CRITERIA (1A above)
   OR
   2B Photograph of dry vernal pool
   OR
   2C Scientific evidence (e.g. seining) that documents the absence of fish

3. Physical criteria:
   Clear photographs or video of the vernal pool demonstrating the lack of permanently flowing connections to larger wetlands

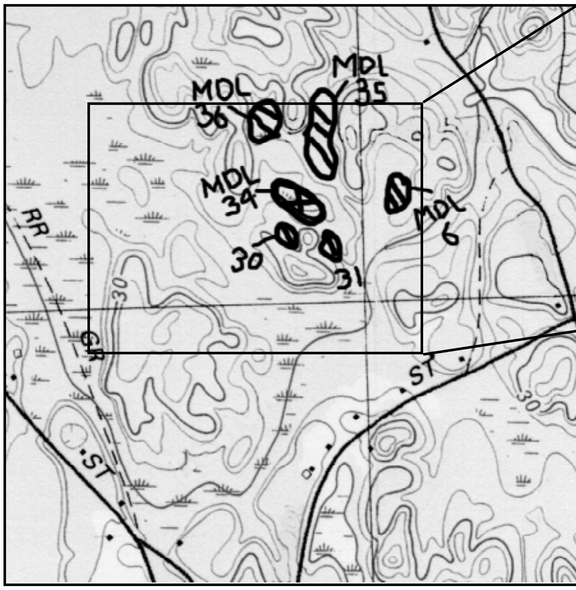
MAPPING REQUIREMENTS

It is critical to provide maps that are accurate and clear when submitting information for state vernal pool certification. A 1:24,000 or 1:25,000 scale **U.S. Geological Survey topographic map is required,** and additional maps that clarify the position of the vernal pool must be submitted. Many maps are acceptable fro this purpose. Large scale street maps generally are not acceptable as supporting maps.

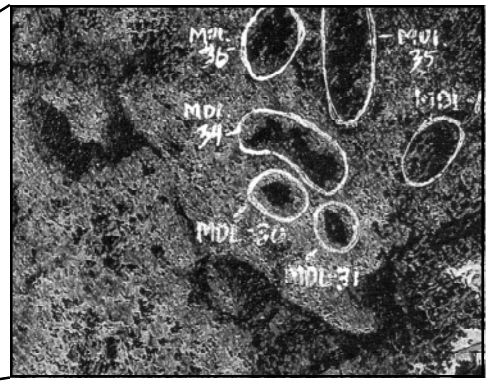
At least one from each of the following groups must be submitted:

GROUP 1	GROUP 2
USGS topographic: The location of the vernal pool must be clearly and accurately marked with an 'X' or dot	**Aerial photograph** Large scale (1:12,000 or better) with pool clearly visible **Compass directions and distances** Magnetic compass direction and distances from two permanent landmarks within 1000 feet of the pool. Landmarks should be readily identifiable in the field and clearly described on the submitted map **Professional survey** Large scale topographic maps or project plans where the depression is evident

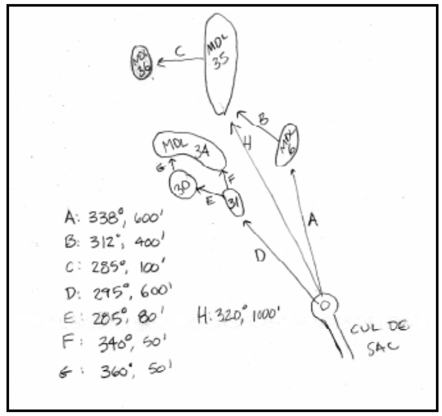
Some examples of required maps



USGS Topographic map section with pools clearly marked



B&W copy of **color infra-red aerial photograph** (1:12,000 scale) with pools also marked



Sketch map with compass directions and distance in feet

Field Observation Form

Application for certification of vernal pool habitat should be made using the standard field observation form (revised in 1999). All requested information should be filled out to the fullest extent possible. Additional directions are provided on the field form.

Please give particular attention to the following items:

Section 1: Written directions to the pool <u>must</u> be provided, noting field markers to help navigation.
Section 2: Please indicate the datesw on which evidence was collected, including the year.
Section 3: Indicate the evidence of obligate and facultative species collected at each pool. If egg masses were found, indicate the number of masses discovered.
Section 4 and 5: Check the boxes corresponding to evidence submitted for each pool (in photographs or tape)
Optional Information: Information provided in this section gives the Natural Heritage & Endangered Species Program a better sense of the type of vernal pools that are being identified through the certification program, and aides in-field identification of the pools should anyone need to visit it. This section is optional, but provides very helpful information.
Section 6: Field forms <u>must be signed</u> at the bottom of page 2.

Incomplete submissions will be returned in full with a letter indicating any missing information. When the requested information has been collected, the application may be resubmitted.

Submit completed applications to:

Vernal Pool Certification
Natural Heritage & Endangered Species Program
Route 135
Westborough, MA 01581

Natural Heritage & Endangered Species Program
Massachusetts Division of Fisheries and Wildlife

Vernal Pool Field Observation Form

(7/99)

(For use with *Guidelines for Certification of Vernal Pool Habitat*)

For office use only.

1. Pool location

THIS INFORMATION MUST BE SUBMITTED

Town ______________ County ______________

USGS Quadrangle name ______________ ☐ SERIES 7.5' X 7.5' ☐ SERIES 7.5' X 15'

WRITTEN DIRECTIONS TO POOL: ______________

(USE ADDITIONAL PAGES, IF NECESSARY.)

2. Observation dates

First date pool/species observed ______________

Last date pool observed ______________ Last date species observed ______________

3 A. Evidence: obligate amphibians

Indicate date of observation.

* = RARE SPECIES	COURTING ADULTS	SPERMATOPHORES	EGG MASSES (2+)	SALAMANDER LARVAE	TRANSFORMING JUVENILES
SPOTTED SALAMANDER					
* BLUE-SPOTTED SALAMANDER					
* JEFFERSON SALAMANDER					
* MARBLED SALAMANDER					
UNIDENTIFIED MOLE SALAMANDER					
	BREEDING CHORUS	MATED PAIRS	EGG MASSES (2+)	FROG TADPOLES	TRANSFORMING JUVENILES
WOOD FROG					
* SPADEFOOT TOAD					

Instructions

FOR COMPLETE INFORMATION ABOUT CERTIFICATION, REFER TO *GUIDELINES FOR CERTIFICATION OF VERNAL POOL HABITAT*.

PROVIDE ALL OF THE INFORMATION REQUESTED IN BOXES 1-6. IF MORE SPACE IS REQUIRED, ATTACH ADDITIONAL PAGES. INCLUDE ALL REQUIRED PHOTOGRAPHS AND DOCUMENTATION. SIGN THE FORM IN THE AREA PROVIDED ON THE REVERSE SIDE. **INCOMPLETE OR UNSIGNED SUBMISSIONS WILL BE RETURNED.**

THE FOLLOWING INSTRUCTIONS REFER TO EACH OF THE NUMBERED BOXES.

1. THE 7.5 X 7.5 SERIES HAS THE LEGEND "7.5 MINUTE SERIES" IN THE UPPER RIGHT HAND CORNER ALONG WITH THE QUADRANGLE NAME. THE 7.5 X 15 MINUTE SERIES IS SO LABELED IN THE UPPER RIGHT HAND CORNER AND HAS THE QUADRANGLE NAME IN THE LOWER RIGHT CORNER.
WRITTEN DIRECTIONS **MUST** BE INCLUDED.

2 INDICATE THE FIRST AND LAST DATES THAT THE POOL OR ITS BIOLOGICAL COMPONENTS WERE OBSERVED.

3. PART A AND B ARE FOR CERTIFICATION BY OBLIGATE SPECIES. PART C IS EITHER FOR ADDITIONAL INFORMATION (APPRECIATED) OR FOR CERTIFICATION BY THE FACULTATIVE SPECIES. IF CERTIFYING BY OBLIGATE SPECIES, PROVIDE A PHOTOGRAPH OF THE POOL HOLDING WATER AND AT LEAST ONE PHOTOGRAPH (OR AUDIO TAPE FOR CHORUSING) OF BREEDING ACTIVITY.
FOR CERTIFICATION BY FACULTATIVE SPECIES, PROVIDE PHOTOGRAPHS OF THE POOL HOLDING WATER AND PHOTOGRAPHS (OR TAPES) OF THE FACULTATIVE SPECIES AS REQUIRED. ADDITIONALLY, PROVIDE A PHOTOGRAPH OF THE POOL WHEN DRY OR OTHERWISE PROVE THAT IT HAS NO FISH.

3 B. Evidence: fairy shrimp

DATE OBSERVED ______________

3 C. Evidence: facultative organisms

Two or more must be documented. Indicate date of observation.

* = RARE SPECIES	DATE OBSERVED	ACTIVITY OBSERVED
BREEDING SPRING PEEPERS		
BREEDING GRAY TREEFROGS		
BREEDING GREEN FROGS		
BREEDING LEOPARD FROGS		
BREEDING PICKEREL FROGS		
BREEDING AMERICAN TOADS		
BREEDING FOWLER'S TOADS		
* BREEDING FOUR-TOED SALAMANDERS		
RED-SPOTTED NEWT (ADULTS)		
* SPOTTED TURTLES		
* WOOD TURTLES		
* BLANDINGS TURTLES		

	DATE OBSERVED	ACTIVITY OBSERVED
PAINTED TURTLES		
SNAPPING TURTLES		
PREDACEOUS DIVING BEETLE LARVAE		
WATER SCORPIONS		
DRAGONFLY NYMPHS		
DAMSELFLY NYMPHS		
DOBSONFLY LARVAE		
WHIRLIGIG BEETLE LARVAE		
CADDISFLY LARVAE		
LEECHES		
FINGERNAIL (FRESHWATER) CLAMS		
AMPHIBIOUS AIR-BREATHING SNAILS		

Instructions (continued)

4. Indicate the photographs being submitted. Label, date, and sign all photos.

5. Mark the pool clearly on all maps. The pool must be clearly distinguished from other wetlands and be relocateable by others. Provide any maps that would help someone unfamiliar with the area locate the vernal pool in the field.

6. The form **must** be signed. Unsigned submissions will be returned without further action.

Optional information:

Property owner. Provide information about property owner(s), if known. It is recommended that you seek property owner permission prior to certification activities.

Rare species. A photograph is necessary for documentation of rare species habitat.

Description. Provide any information that will distinguish the pool from other wetlands (boulders, debris, tree species, etc.).

4. Photographs

must be labeled, dated, and signed.

- ☐ pool holding water
- ☐ obligate +/or facultative species
- ☐ dry pool (**required** for evidence 3C)

5. Maps submitted

- ☐ USGS topographic map (**required**)

and one or more of the following:

- ☐ aerial photograph
- ☐ distances/compass directions
- ☐ professional survey
- ☐ large scale topo
- ☐ other_____________

optional extra information

- ☐ sketch map of area
- ☐ assessor's map
- ☐ GPS longitude/latitude coordinates

____

Optional information

Although the following information is not required for certification, it is useful to NHESP to possibly better protect the vernal pool, its habitat and species.

Property owner

It is strongly recommended that landowner permission be obtained prior to collecting certification documentation.

Name ______________________________

Address ______________________________

____

Town ____________________ State ____ ZIP ______

Rare wetland species

☐ Y ☐ N Were any rare state-listed species observed using this pool?

☐ Y ☐ N Is a photograph of the rare species included with this filing?

Description of pool and surroundings

Dimensions: approximate length approximate width

approximate depth

Describe distinctive features (roads, structures, boulders, etc.) which are visible from or near the pool.

Are there other distinctive features about this pool (vegetation types, abandoned vehicles, foot trails, etc.) that would help someone recognize it?

6. Observer information & signature

Name ______________________________

Address ______________________________

____

Town ____________________ State ____ ZIP ______

Telephone ______________________________

e-mail ______________________________

I hereby certify under the pains and penalties of perjury that the information contained in this report is true and complete to the best of my knowledge.

Signature ______________________________ Date __________

Send completed form and supporting documentation to:

NH&ESP
Vernal Pool Certification
MA Division of Fisheries & Wildlife
Route 135
Westborough, MA 01581

All submissions and supporting documents will be retained by the Natural Heritage & Endangered Species Program. Information submitted on this form and other documents is part of the public record and is available to interested parties under the State Documents Request Law.

Natural Heritage & Endangered Species Program
Massachusetts Division of Fisheries and Wildlife
Vernal Pool Field Observation Form

(7/99) (For use with *Guidelines for Certification of Vernal Pool Habitat*)

For office use only.

1. Pool location

THIS INFORMATION MUST BE SUBMITTED

Town ______________________ County ______________________

USGS Quadrangle name ______________________ ☐ SERIES 7.5' X 7.5' ☐ SERIES 7.5' X 15'

WRITTEN DIRECTIONS TO POOL: ______________________

(USE ADDITIONAL PAGES, IF NECESSARY.)

Instructions

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2. Observation dates

First date pool/species observed __________

Last date pool observed __________ Last date species observed __________

3 A. Evidence: obligate amphibians

Indicate date of observation.

* = RARE SPECIES	COURTING ADULTS	SPERMATOPHORES	EGG MASSES (2+)	SALAMANDER LARVAE	TRANSFORMING JUVENILES
SPOTTED SALAMANDER					
* BLUE-SPOTTED SALAMANDER					
* JEFFERSON SALAMANDER					
* MARBLED SALAMANDER					
UNIDENTIFIED MOLE SALAMANDER					

	BREEDING CHORUS	MATED PAIRS	EGG MASSES (2+)	FROG TADPOLES	TRANSFORMING JUVENILES
WOOD FROG					
* SPADEFOOT TOAD					

3 B. Evidence: fairy shrimp

DATE OBSERVED __________

3 C. Evidence: facultative organisms

Two or more must be documented. Indicate date of observation.

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BREEDING GRAY TREEFROGS		
BREEDING GREEN FROGS		
BREEDING LEOPARD FROGS		
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BREEDING AMERICAN TOADS		
BREEDING FOWLER'S TOADS		
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* BLANDINGS TURTLES		

	DATE OBSERVED	ACTIVITY OBSERVED
PAINTED TURTLES		
SNAPPING TURTLES		
PREDACEOUS DIVING BEETLE LARVAE		
WATER SCORPIONS		
DRAGONFLY NYMPHS		
DAMSELFLY NYMPHS		
DOBSONFLY LARVAE		
WHIRLIGIG BEETLE LARVAE		
CADDISFLY LARVAE		
LEECHES		
FINGERNAIL (FRESHWATER) CLAMS		
AMPHIBIOUS AIR-BREATHING SNAILS		

Instructions (continued)

4. Indicate the photographs being submitted. Label, date, and sign all photos.
5. Mark the pool clearly on all maps. The pool must be clearly distinguished from other wetlands and be relocateable by others. Provide any maps that would help someone unfamiliar with the area locate the vernal pool in the field.
6. The form **must** be signed. Unsigned submissions will be returned without further action.

Optional information:
Property owner. Provide information about property owner(s), if known. It is recommended that you seek property owner permission prior to certification activities.
Rare species. A photograph is necessary for documentation of rare species habitat.
Description. Provide any information that will distinguish the pool from other wetlands (boulders, debris, tree species, etc.).

4. Photographs

must be labeled, dated, and signed.

- ☐ pool holding water
- ☐ obligate +/or facultative species
- ☐ dry pool (**required** for evidence 3C)

5. Maps submitted

- ☐ USGS topographic map (**required**)

and one or more of the following:

- ☐ aerial photograph
- ☐ distances/compass directions
- ☐ professional survey
- ☐ large scale topo
- ☐ other______________

optional extra information

- ☐ sketch map of area
- ☐ assessor's map
- ☐ GPS longitude/latitude coordinates

____

Optional information

Although the following information is not required for certification, it is useful to NHESP to possibly better protect the vernal pool, its habitat and species.

Property owner

It is strongly recommended that landowner permission be obtained prior to collecting certification documentation.

Name ______________________________

Address ______________________________

____

Town ______________ State____ ZIP________

Rare wetland species

☐ Y ☐ N Were any rare state-listed species observed using this pool?

☐ Y ☐ N Is a photograph of the rare species included with this filing?

Description of pool and surroundings

Dimensions: approximate length approximate width

approximate depth

Describe distinctive features (roads, structures, boulders, etc.) which are visible from or near the pool.

Are there other distinctive features about this pool (vegetation types, abandoned vehicles, foot trails, etc.) that would help someone recognize it?

6. Observer information & signature

Name ______________________________

Address ______________________________

____

Town ______________ State____ ZIP________

Telephone ______________________________

e-mail ______________________________

I hereby certify under the pains and penalties of perjury that the information contained in this report is true and complete to the best of my knowledge.

Signature ______________________ Date __________

Send completed form and supporting documentation to:

NH&ESP
Vernal Pool Certification
MA Division of Fisheries & Wildlife
Route 135
Westborough, MA 01581

All submissions and supporting documents will be retained by the Natural Heritage & Endangered Species Program. Information submitted on this form and other documents is part of the public record and is available to interested parties under the State Documents Request Law.

Critical Habitat Features & Activities Checklist

This checklist provides a convenient way to document the presence of critical wildlife habitat features and describe activities where even small-scale projects are likely to have significant impacts on wildlife habitat functions. Projects affecting larger areas (> 5000 sq. ft.) should be evaluated using Appendices B & C.

When any project within BVW and Riverfront Area, and above-threshold projects in other resource areas, will alter one or more of the following critical habitat features, the conservation commission has sufficient grounds to find that it will result in significant adverse impacts to wildlife habitat functions.[1] For below-threshold projects, the conservation commission may use this information to request the applicant to avoid, minimize and mitigate adverse impacts to the identified feature(s).

The activities on the checklist may adversely affect wildlife habitat functions even when the area of impact is less than the thresholds listed in section III. Conservation commissions may use this information (for bordering vegetated wetlands and riverfront area) as grounds for a determination that the project will result in significant adverse impacts, or (for other resource areas) to *request* (but not require) the applicant to avoid, minimize and mitigate adverse impacts caused by the proposed activity or activities.[2]

The checklist is followed by background information that explains the particular reason(s) why a habitat feature or activity is on the list.

---

[1] This checklist is not intended as an exhaustive list of grounds for determining when small-scale projects will result in significant adverse impacts to wildlife habitat. Commissions may confront other circumstances not represented on this list that also would serve as grounds for such a judgment.

[2] Although the Wetlands Act does not provide jurisdiction over impacts in buffer zones (unless they will also alter a resource area), conservation commissions should actively negotiate with project proponents to avoid altering these critical habitat features when they occur in areas adjacent to resource areas.

Critical Habitat Features & Activities Checklist

CRITICAL HABITAT FEATURES

- ❑ habitat for state-listed animal species
- ❑ isolated wetlands >5000 sq. ft.
- ❑ sphagnum hummocks and pools suitable to serve as nesting habitat for four-toed salamanders
- ❑ depressions that hold standing water with potential to provide vernal pool habitat
- ❑ areas within 200' of vernal pools
- ❑ trees with large cavities (>12" diameter at cavity entrance)
- ❑ existing beaver, mink or otter dens
- ❑ existing nest trees for birds that traditionally reuse nests (bald eagle, osprey, great blue heron)
- ❑ freshwater mussel beds
- ❑ areas that are known to contain open water in winter with the capacity to serve as significant waterfowl winter habitat
- ❑ turtle nesting areas
- ❑ vertical sandy banks (bank swallows and kingfishers)
- ❑ the following habitat characteristics when not commonly encountered in the surrounding area:
    - ❑ riffle zones (e.g. in eastern MA)
    - ❑ springs
    - ❑ gravel stream bottoms (trout and salmon nesting substrate)
    - ❑ plunge pools or deep holes in streams
    - ❑ medium to large, flat rock substrates in streams
- ❑ project area is the sole connector between habitats >50 acres in size

ACTIVITIES

- ❑ structures that obstruct animal movement
- ❑ activities that result in significant disturbance within:
    - ❑ 100' of existing beaver, mink or otter dens,
    - ❑ 200' of existing osprey or great blue heron nests, or
    - ❑ 1400' of existing bald eagle nests
- ❑ bank stabilization projects using hard structure solutions that:
    - ❑ significantly affect ability of stream channel to naturally shift and meander, or
    - ❑ create a discontinuity in cover that would inhibit animal passage.
- ❑ dredging projects

Background Information

Critical Habitat Features

1. Isolated wetlands. Although isolated wetlands are not explicitly protected under the Wetlands Protection Act, they typically provide all or most of the habitat functions provided by bordering vegetated wetlands. Where significant areas of isolated wetland (>5000 square feet) exist within other resource areas (land subject to flooding, riverfront area), they should be considered as especially valuable habitat features.

2. Depressions that hold standing water with potential to provide vernal pool habitat. Even if not certified as vernal pools, depressions that hold standing water are important habitat features, especially if they have the potential to provide vernal pool habitat.

3. Areas within 200 feet of vernal pools.[3] Where vernal pools have been certified or identified by evidence from a competent source, the areas within 200 feet of those pools are especially important as upland, migration, and dispersal habitat for vernal pool amphibians and reptiles. It may be appropriate to conclude that activities within 200 feet of vernal pools will not result in adverse impacts to wildlife habitat when the area in question does not in its current condition provide appropriate habitat for vernal pool wildlife (e.g. parking lots, lawns). Below-threshold projects that take place beyond 200 feet of a vernal pool may hamper the wildlife habitat function of a vernal pool when it affects the last area of available upland habitat for vernal pool amphibians and reptiles (e.g. a small wedge of appropriate habitat within a previously altered landscape).

4. Sphagnum hummocks and pools of standing water suitable to serve as nesting habitat for four-toed salamanders (*Hemidactylium scutatum*). This state-listed amphibian requires a particular nesting habitat of sphagnum hummocks directly adjacent to pools of water that persist into the summer. This nesting habitat is generally found in limited supply throughout Massachusetts and should be protected wherever it occurs.

5. Trees with large cavities. Trees with large cavities (≥12" diameter at the cavity entrance), especially ones close to water, are particularly valuable for a variety of wildlife, including wood ducks, hooded mergansers, barred owls, mink and otter. This critical habitat feature is very limited in supply throughout much of Massachusetts.

6. Existing beaver, mink or otter dens. These are important for their existing wildlife occupants as well as future occupants of the same or different species.

7. Existing bald eagle, osprey, and great blue heron nesting trees. These species typically reuse the same nests for many years.

8. Turtle nesting areas. Turtles require particular soil conditions and sun exposure within reasonable travel distances from appropriate aquatic habitats. Availability of appropriate nesting areas may be a factor limiting turtle abundance and distribution in Massachusetts. Turtle nesting typically occurs during the month of June.

9. Dense beds of freshwater mussels. Freshwater mussels are a valuable food resource for raccoon, mink, otter and various species of waterfowl.

10. Vertical sandy banks. Bank and Northern rough-winged swallows and kingfishers prefer vertical sandy banks near water for nesting. This important habitat feature is generally found in limited supply throughout Massachusetts.

[3] Within the limits of jurisdiction.

11. Areas that are known to contain open water in winter with the capacity to serve as significant waterfowl winter habitat. Relatively few areas of significant open freshwater are available for wintering waterfowl in Massachusetts. Those areas that do exist must be protected from alteration or disturbance.

12. The following habitat features when not commonly encountered in the surrounding area. Although these habitat features may be very common in some areas, they are quite rare and extremely valuable in other parts of Massachusetts.

    a. stream bed riffle zones (especially rare in eastern MA, the Cape and the Islands)
    b. springs (important for maintaining base flows and moderating water temperatures)
    c. gravel stream bottoms (trout and salmon nesting substrate)
    d. plunge pools or deep holes in streams (important winter and dry weather habitats for fish and salamanders)
    e. medium to large, flat rock substrates in streams (important for salamander nesting habitat and invertebrate production)

13. Project area is the sole connector between areas of habitat >50 acres in size. Even relatively small areas can be very important for connecting other areas of significant habitat. Even small projects have the potential to disrupt animal movement and habitat connectivity if they alter small areas of connecting habitat.

Activities

The following activities may adversely affect wildlife habitat functions even when the area of work is relatively small.

1. Structures that obstruct animal movement. A variety of structures have the potential to be significant obstacles to animal movement. These include, but are not limited to, fences, stone walls, retaining walls, standard and granite curbs, railroad tracks, and steep-sided ditches. A number of issues come into play in determining whether a structure will significantly obstruct animal movement, including design, size and orientation of the structure, surrounding land use, and availability of reasonable alternative routes for animal passage. In evaluating the impacts of structures on animal movement it is important to keep in mind the needs of some of the least mobile wildlife species, such as box turtles, turtle hatchlings, snakes, salamanders, and moles.

2. Activities that result in significant disturbance within:

    a. 100 feet of existing beaver, mink or otter dens,
    b. 200 feet of existing osprey or great blue heron nests, or
    c. 1400 feet of existing bald eagle nests.

3. Bank stabilization projects using hard structure solutions that:

    a. significantly affect the ability of the stream or river channel to naturally shift and meander, or
    b. create a discontinuity in cover that would inhibit animal passage.

4. Dredging projects. Dredging projects are so likely to result in impacts beyond the dredged area (due to downstream impacts of suspended sediments or draw down impacts) that they will probably result in significant adverse impacts to wildlife habitat. Some dredging projects may result in a net benefit to wildlife by restoring habitat value in degraded systems. However, even these projects require careful review to ensure that potential adverse impacts are minimized. Dredging projects for the primary purpose of habitat restoration may take advantage of the procedures for Division review and approval of wildlife habitat management activities (Appendix E). Wildlife habitat management practices that are reviewed and approved by the Division are presumed to have no adverse effect on wildlife habitat.[4]

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[4] 310 CMR 10.60 (1)(c)

Wildlife Habitat Evaluation
Summary Sheet

Project Name:

Location:

Date:

Size of Wetland Assessment Area:

Wetland Types Present within the Assessment Area (Cowardin et al.)

	System	Subsystem	Class	Area (acres or sq. ft.)
1.				
2.				
3.				
4.				
5.				

Area of “Lands Subject to Flooding” within the Assessment Area: ________________

Area of “Riverfront Area” within the Assessment Area: ________________

Sketch map of the Assessment Area showing Wetland Types, Lands Subject to Flooding, Riverfront Areas and Surrounding Habitats:

Wildlife Habitat Evaluation Field Data Form

Instructions for Completing the Wildlife Habitat Field Data Form

The time required to complete a habitat evaluation varies according to the size and complexity of the site. A typical assessment of one acre with a mix of wetland and upland resource areas should require a day or less for data collection and another half to full day to prepare the narrative. Additional time will be needed if site plans, restoration or mitigation plans are required.

The field data form consists of five sections: general information, site description, important habitat features, landscape context, and habitat degradation.

General Information
In this section provide the project name and location, date or dates of field data collection, date the form was completed, and the person completing the form. It is generally expected that the person who completes the form and writes the narrative will be the same person who collects the field data. To verify this, a statement is included on the form that "the information on this data sheet is based on my observations unless otherwise indicated" with a place for the signature of the person completing the form.

Site Description
Wetlands should be described according to the Cowardin classification for “system,” “subsystem,” “class,” and “hydrological modifiers.”

Soils should be characterized according to information presented in the most recent soil survey for the area, supplemented, as needed, by field data. Include information on soil survey unit, drainage class, texture in the upper part, and soil depth. In this section also note whether or not small mammal burrows are present in the evaluation area.[1]

Vegetation should be characterized by estimating percent cover for trees (>20'), shrubs (<20'), woody vines, herbaceous plants, mosses, and aquatic plants (submergent, floating and floating leafed plants). Plant species that comprise 10 percent or more of the vegetative cover in each stratum should be listed and dominant species identified.

Important Habitat Features
This section provides an extensive checklist of habitat features that might occur on a site along with references to wildlife that depend on each particular feature. When a particular feature is present, additional information should be recorded, on the back of the sheet or a separate sheet of paper, describing the habitat feature, quantifying the feature, and listing wildlife species that are likely to utilize the feature as it occurs on the site. For some habitat features it may be necessary to estimate seasonal hydrology from indicators that may be present during a site visit.

Landscape Context
The section on landscape context is divided into two subsections, habitat continuity and connectivity with adjoining natural habitats. It may be necessary to consult aerial photographs[2] or maps to accurately characterize the landscape context for an assessment area.

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[1] Such burrows indicate soil suitability for small mammals and are important habitat features for salamanders and snakes.
[2] A variety of aerial photographs are available from the Earth Science Information Office, Blaisdell House, University of Massachusetts, Amherst, MA 01003, (413 545-0359).

Habitat continuity is related to the size of habitat patches or interrelated mosaics of habitat on the landscape. Patch size is an important characteristic affecting whether or not an area provides suitable habitat for some wildlife species. Although size thresholds differ from species to species, large blocks of unfragmented habitat are essential to these area-sensitive wildlife species.

Many wetland-dependent birds that are of conservation concern in New England (waterfowl, waders, and water birds) require relatively large areas of emergent marsh habitat. The larger the marsh, the more species it can support. Likewise, it is known that some species of forest nesting birds are area-sensitive, requiring relatively large blocks of unfragmented forests (upland forest, forested wetland or a combination of the two). In addition to the actual size of a forest patch, the ratio of forest interior to edge is an important characteristic affecting the abundance and composition of forest birds utilizing an area. Other wildlife, such as waterfowl, large mammals and turtles, utilize a variety of wetland types arranged in relatively close proximity to each other. These wetland complexes are better able to meet the varied habitat requirement of these species than could any single wetland type.

The field data form provides a section for recording the size classes of emergent marsh, wetland complex, and contiguous forest habitat associated with the assessment area. The lowest size categories are large enough to have value for area-sensitive species. The larger the size class of habitat involved, typically the more “area-sensitive” species it will likely support. Thus, patch size itself is an important habitat characteristic for some areas. For habitat blocks and wetland complexes in any of the size classes listed on the form, applicants should include in the narrative an evaluation of the project's likely impacts on “area-sensitive” wildlife species.

Habitat connectivity within a landscape is important for providing migratory habitat for wildlife as well as for maintaining regional population dynamics that are essential for the long-term viability of local wildlife populations. The field data form includes a section for use in characterizing the landscape context of a proposed project site. Five options are available to choose from to characterize the relationship of the site to surrounding habitats. These include:

1. No direct connections to adjacent areas of wildlife habitat

2. Connectors numerous or assessment area is imbedded in a large area of natural habitat

3. Assessment area contributes to a limited number of connectors to adjacent areas of habitat

4. Assessment area serves a part of a sole connector to adjacent areas of habitat

5. Assessment area serves as the only connector to adjacent areas of habitat

Habitat connectivity issues should be addressed in the narrative portion of wildlife habitat evaluations.

Habitat Degradation

The last section of the field data form provides an opportunity to record evidence of significant habitat degradation, including chemical contamination, dumping, erosion or sedimentation problems, invasive exotic plants or animals, road or highway disturbance, and other human disturbance. A detailed study of potential habitat degradation is not required. However, if degradation is evident and will likely affect the habitat value of the area, it should be noted on the form, and described and discussed in the wildlife evaluation narrative.

Wildlife Habitat Evaluation
Field Data Form
(For each wetland type or upland floodplain/riverfront area)

Project Name ____

Location ____

Date(s) of site visit(s) and data collection ______________________________

Date this form was completed ______________________________

Person completing form ______________________________

"The information on this data sheet is based on my observations unless otherwise indicated"

Signature: ______________________________

SITE DESCRIPTION

System: ______________________

Subsystem: ______________________

Class: ______________________

Soils

Soil Survey Unit ______________________

Drainage Class ______________________

Texture (upper part) ______________________

Depth ______________________

Are small mammal burrows present? ________

Hydrology/Water Regime:

____ Permanently flooded

____ Intermittently exposed

____ Semi-permanently flooded

____ Seasonally flooded

____ Saturated

____ Temporarily flooded

____ Intermittently flooded

____ Artificially flooded

Plants

%Cover: _____ Trees (>20') _____ Shrubs (<20') ______ Woody Vines _____ Mosses

_____ Herbaceous ______ Aquatics (submergent, floating & floating leafed)

Plant Lists (species that comprise 10% or more of the vegetative cover in each strata; "*" designates a dominant plant species for the strata):

Strata	Plant Species	Strata	Plant Species

IMPORTANT HABITAT FEATURES

If the following habitat characteristics are present, describe & quantify them on the back of this sheet

Wildlife Food

Important Wetland/Aquatic Food Plants (smartweeds, pondweeds, wild rice, bulrush, wild celery)

______ Abundant ______ Present ______ Absent

Important Upland/Wetland Food Plants (hard mast and fruit/berry producers)

______ Abundant ______ Present ______ Absent

Shrub thickets or streambeds with abundant earthworms (American woodcock)

______ Present ______ Absent

Shrub and/or herbaceous vegetation suitable for veery nesting ______ Present ______ Absent

Number (or density) of Standing Dead Trees (potential for cavities):

______ 6-12" dbh ______ 12-18" dbh _____ 18-24" dbh ______ >24" dbh

Number of Tree Cavities in trunks or limbs of:

______ 6-12" diameter (tree swallow, saw whet owl, screech owl, bluebird, other songbirds)

______ 12-18" diameter (hooded merganser, wood duck, common goldeneye, mink)

______ >18" diameter (hooded merganser, wood duck, common goldeneye, common merganser, barred owl, mink, raccoon, fisher)

Cover/Perches/Basking/Denning Habitat

____ Dense herbaceous cover (voles, small mammals, amphibians & reptiles)

____ Large woody debris on the ground (small mammals, mink, amphibians & reptiles)

____ Rocks, crevices, logs, tree roots or hummocks under water's surface (turtles, snakes, frogs)

____ Rocks, crevices, fallen logs, overhanging branches or hummocks at, or within 1m above the water's surface (turtles, snakes, frogs, wading birds, wood duck, mink, raccoon)

____ Rock piles, crevices or hollow logs suitable for:

____ otter ____mink ____ porcupine ____ bear ____ bobcat ____ turkey vulture

____ Live or dead standing vegetation overhanging water or offering good visibility of open water (osprey, kingfisher, flycatchers, cedar waxwings)

Depressions that may serve as seasonal (vernal/autumnal) pools: ____ present ____ absent

Standing water present at least part of the growing season, suitable for use by:

____ breeding amphibians ____ non-breeding amphibians (foraging, rehydration)

____ spotted turtle ____ foraging waterfowl

Sphagnum hummocks or mats, moss covered logs or saturated logs, overhanging or directly adjacent to pools of standing water in spring (four-toed salamander): ____ present ____ absent

Medium to large (> 6"), flat rocks within a stream (cover for stream salamanders and nesting habitat for spring & two-lined salamanders) ____ present ____ absent

IMPORTANT HABITAT FEATURES (*If present, describe & quantify them on the back of this sheet)*

Flat rocks and logs on banks or within exposed portions of streambeds (cover for stream salamanders and nesting habitat for dusky salamanders) ____ present ____ absent

Areas of ice-free open water in winter: ____ present ____ absent

Mud flats ____ present ____ absent

Underwater banks of fine silt and/or clay (beaver, muskrat, otter) ____ present ____ absent

Vertical sandy banks (bank swallow, kingfisher) ____ present ____ absent

Exposed areas of well-drained, sandy soil suitable for turtle nesting ____ present ____ absent

WILDLIFE DENS/NESTS (*If present, describe & quantify them on the back of this sheet)*

Turtle nesting sites: ______ present ______ absent

Bank swallow colony: ______ present ______ absent

Nest(s) present of: ______ Bald Eagle ______ Osprey ______ Great Blue Heron

Den(s) present of: ______ Otter ______ Mink ______ Beaver

Project areas is within:

____ 100’ of beaver, mink or otter den, bank swallow colony or turtle nesting area

____ 200’ of Great blue heron or osprey nest(s)

____ 1400’ of a bald eagle nest

EMERGENT WETLANDS (*If present, describe & quantify them on the back of this sheet)*

Emergent wetland vegetation at least seasonally flooded during the growing season (wood duck, green heron, black-crowned night heron, King rail, Virginia rail, Coot)

Flooded > 5 cm ____ present ____ absent

Flooded > 25 cm (pied-billed grebe) ____ present ____ absent

Persistent emergent wetland vegetation at least seasonally flooded during the growing season (mallard, American bittern, sora, common snipe, red-winged blackbird, swamp sparrow, marsh wren)

Flooded > 5 cm ____ present ____ absent

Flooded > 25 cm (least bittern, common moorhen) ____ present ____ absent

Cattail emergent wetland vegetation at least seasonally flooded during the growing season

Flooded > 5 cm (marsh wren) ____ present ____ absent

Flooded > 25 cm (least bittern, common moorhen) ____ present ____ absent

Fine-leafed emergent wetland vegetation (grasses and sedges) at least seasonally flooded during the growing season (common snipe, spotted sandpiper, sedge wren)

Flooded > 5 cm ____ present ____ absent

Flooded > 25 cm (least bittern, common moorhen) ____ present ____ absent

LANDSCAPE CONTEXT

Habitat Continuity (*If present, describe the landscape context on the back of this sheet and its importance for area-sensitive species)*)

Is the assessment area part of an emergent marsh at least	1.0 acres in size?	____ yes	____ no
(marsh and waterbirds)	2.0 acres in size?	____ yes	____ no
	5.0 acres in size?	____ yes	____ no
	10.0 acres in size?	____ yes	____ no
Is the assessment area part of a wetland complex at least	2.5 acres in size?	____ yes	____ no
(turtles, frogs, waterfowl, mammals)	5.0 acres in size?	____ yes	____ no
	10.0 acres in size?	____ yes	____ no
	25.0 acres in size?	____ yes	____ no
Is the assessment area part of contiguous forested habitat at least			
(forest interior nesting birds)	50 acres in size?	____ yes	____ no
	100 acres in size?	____ yes	____ no
	250 acres in size?	____ yes	____ no
	500 acres in size?	____ yes	____ no

Connectivity with adjoining natural habitats

______ No direct connections to adjacent areas of wildlife habitat (little connectivity function)

______ Connectors numerous or assessment area is imbedded in a large area of natural habitat (limited connectivity function)

______ Assessment area contributes to a limited number of connectors to adjacent areas of habitat (somewhat important for connectivity function)

______ Assessment area serves as *part of* a sole connector to adjacent areas of habitat (important for connectivity function)

______ Assessment area serves as *only* connector to adjacent areas of habitat (very important for connectivity function)

HABITAT DEGRADATION (Describe degradation and impacts on wildlife habitat value on back of the sheet)

______ Evidence of significant chemical contamination

______ Evidence of significant levels of dumping

______ Evidence of significant erosion or sedimentation problems

______ Significant invasion of exotic plants (e.g. purple loosestrife, *Phragmites*, glossy buckthorn)

______ Disturbance from roads or highways

______ Other human disturbance

United States
Department of
Agriculture

Natural
Resources
Conservation
Service

National Water and Climate Center
Technical Note 99–1

Stream Visual Assessment Protocol

Issued December 1998

Cover photo: Stream in Clayton County, Iowa, exhibiting an impaired riparian zone.

(NWCC Technical Note 99–1, Stream Visual Assessment Protocol, December 1998)

Preface

This document presents an easy-to-use assessment protocol to evaluate the condition of aquatic ecosystems associated with streams. The protocol does not require expertise in aquatic biology or extensive training. Least-impacted reference sites are used to provide a standard of comparison. The use of reference sites is variable depending on how the state chooses to implement the protocol. The state may modify the protocol based on a system of stream classification and a series of reference sites. Instructions for modifying the protocol are provided in the technical information section. Aternatively, a user may use reference sites in a less structured manner as a point of reference when applying the protocol.

The Stream Visual Assessment Protocol is the first level in a hierarchy of ecological assessment protocols. More sophisticated assessment methods may be found in the Stream Ecological Assessment Field Handbook. The field handbook also contains background information on basic stream ecology. Information on chemical monitoring of surface water and groundwater may be found in the National Handbook of Water Quality Monitoring.

The protocol is designed to be conducted with the landowner. Educational material is incorporated into the protocol. The document is structured so that the protocol (pp. 7–20) can be duplicated to provide a copy to the landowner after completion of an assessment. The assessment is recorded on a single sheet of paper (copied front and back).

Acknowledgments

This protocol was developed by the Natural Resources Conservation Service (NRCS) Aquatic Assessment Workgroup. The principal authors were **Bruce Newton**, limnologist, National Water and Climate Center, NRCS, Portland, OR; **Dr. Catherine Pringle**, associate professor of Aquatic Ecology, University of Georgia, Athens, GA; and **Ronald Bjorkland**, University of Georgia, Athens, GA. The NRCS Aquatic Assessment Workgroup members provided substantial assistance in development, field evaluation, and critical review of the document. These members were:

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Stream Visual Assessment Protocol

Introduction

This assessment protocol provides a basic level of stream health evaluation. It can be successfully applied by conservationists with little biological or hydrological training. It is intended to be conducted with the landowner and incorporates talking points for the conservationist to use during the assessment. This protocol is the first level in a four-part hierarchy of assessment protocols. Tier 2 is the NRCS Water Quality Indicators Guide, Tier 3 is the NRCS Stream Ecological Assessment Field Handbook, and Tier 4 is the intensive bioassessment protocol used by your State water quality agency.

This protocol provides an assessment based primarily on physical conditions within the assessment area. It may not detect some resource problems caused by factors located beyond the area being assessed. The use of higher tier methods is required to more fully assess the ecological condition and to detect problems originating elsewhere in the watershed. However, most landowners are mainly interested in evaluating conditions on their land, and this protocol is well suited to supporting that objective.

What makes for a healthy stream?

A stream is a complex ecosystem in which several biological, physical, and chemical processes interact. Changes in any one characteristic or process have cascading effects throughout the system and result in changes to many aspects of the system.

Some of the factors that influence and determine the integrity of streams are shown in figure 1. Often several factors can combine to cause profound changes. For example, increased nutrient loads alone might not cause a change to a forested stream. But when combined with tree removal and channel widening, the result is to shift the energy dynamics from an aquatic biological community based on leaf litter inputs to one based on algae and macrophytes. The resulting chemical changes caused by algal photosynthesis and respiration and elevated temperatures may further contribute to a completely different biological community.

Many stream processes are in a delicate balance. For example, stream power, sediment load, and channel roughness must be in balance. Hydrologic changes that increase stream power, if not balanced by greater channel complexity and roughness, result in "hungry" water that erodes banks or the stream bottom. Increases in sediment load beyond the transport capacity of the stream leads to deposition, lateral channel movement into streambanks, and channel widening.

Most systems would benefit from increased complexity and diversity in physical structure. Structural complexity is provided by trees fallen into the channel, overhanging banks, roots extending into the flow, pools and riffles, overhanging vegetation, and a variety of bottom materials. This complexity enhances habitat for organisms and also restores hydrologic properties that often have been lost.

Chemical pollution is a factor in most streams. The major categories of chemical pollutants are oxygen depleting substances, such as manure, ammonia, and organic wastes; the nutrients nitrogen and phosphorus; acids, such as from mining or industrial activities; and toxic materials, such as pesticides and salts or metals contained in some drain water. It is important to note that the effects of many chemicals depend on several factors. For example, an increase in the pH caused by excessive algal and aquatic plant growth may cause an otherwise safe concentration of ammonia to become toxic. This is because the equilibrium concentrations of nontoxic ammonium ion and toxic un-ionized ammonia are pH-dependent.

Finally, it is important to recognize that streams and flood plains need to operate as a connected system. Flooding is necessary to maintain the flood plain biological community and to relieve the erosive force of flood discharges by reducing the velocity of the water. Flooding and bankfull flows are also essential for maintaining the instream physical structure. These events scour out pools, clean coarser substrates (gravel, cobbles, and boulders) of fine sediment, and redistribute or introduce woody debris.

What's the stream type?

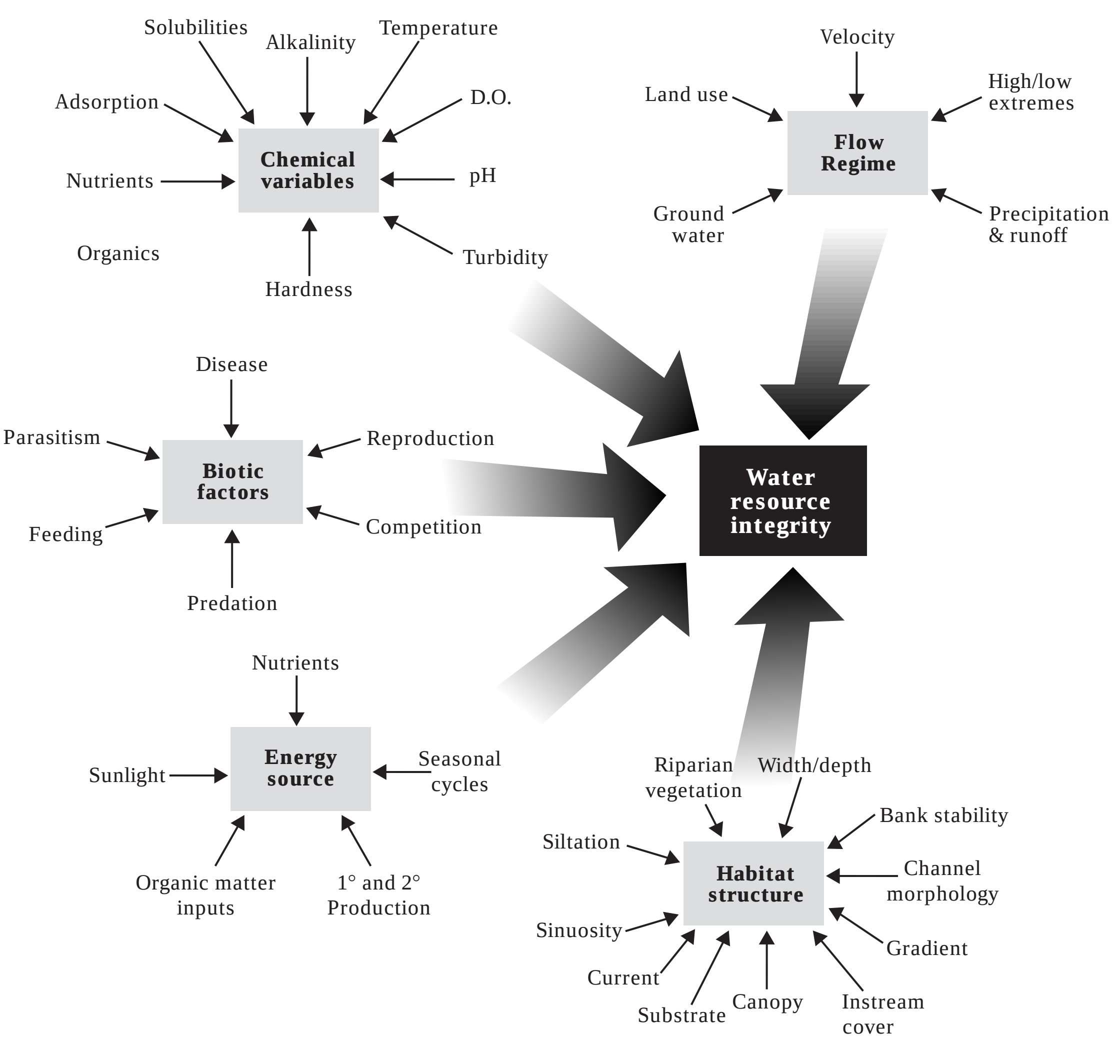
A healthy stream will look and function differently in different parts of the country and in different parts of the landscape. A mountain stream in a shale bedrock is different from a valley stream in alluvial deposits. Coastal streams are different from piedmont streams. Figuring out the different types of streams is called stream classification. Determining what types of streams are in your area is important to assessing the health of a particular stream.

There are many stream classification systems. For the purpose of a general assessment based on biology and habitat, you should think in terms of a three-level classification system based on ecoregion, drainage area, and gradient. *Ecoregions* are geographic areas in which ecosystems are expected to be similar. A national-level ecoregion map is available, and many states are working to develop maps at a higher level of resolution. *Drainage area* is the next most important factor to defining stream type. Finally, the slope or *gradient* of the reach you are assessing will help you determine the stream type. If you are familiar with another classification system, such as Rosgen or Montgomery/Buffington, you should use that system. This protocol may have been adjusted by your state office to reflect stream types common in your area.

Reference sites

One of the most difficult issues associated with stream ecosystems is the question of historic and potential conditions. To assess stream health, we need a benchmark of what the healthy condition is. We can usually assume that historic conditions were healthy. But in areas where streams have been degraded for 150 years or more, knowledge of historic conditions may have been lost. Moreover, in many areas returning to historic conditions is impossible or the historic conditions would not be stable under the current hydrology. Therefore, the question becomes what is the best we can expect for a particular stream. Scientists have grappled with this question for a long time, and the

Figure 1 Factors that influence the integrity of streams (modified from Karr 1986)



consensus that has emerged is to use reference sites within a classification system.

Reference sites represent the best conditions attainable within a particular stream class. The identification and characterization of reference sites is an ongoing effort led in most states by the water quality agency. You should determine whether your state has identified reference sites for the streams in your area. Such reference sites could be in another county or in another state. Unless your state office has provided photographs and other descriptive information, you should visit some reference sites to learn what healthy streams look like as part of your skills development. Visiting reference sites should also be part of your orientation after a move to a new field office.

Using this protocol

This protocol is intended for use in the field with the landowner. Conducting the assessment with the landowner gives you the opportunity to discuss natural resource concerns and conservation opportunities.

Before conducting the assessment, you should determine the following information in the field office:

- ecoregion (if in use in your State)
- drainage area
- stream gradients on the property
- overall position on the landscape

Your opening discussion with landowners should start by acknowledging that they own the land and that you understand that they know their operation best. Point out that streams, from small creeks to large rivers, are a resource that runs throughout the landscape—how they manage their part of the stream affects the entire system. Talk about the benefits of healthy streams and watersheds (improved baseflow, forage, fish, waterfowl, wildlife, aesthetics, reduced flooding downstream, and reduced water pollution). Talk about how restoring streams to a healthy condition is now a national priority.

Explain what will happen during the assessment and what you expect from them. An example follows:

This assessment will tell us how your stream is doing. We'll need to look at sections of the stream that are representative of different conditions. As we do the assessment we'll discuss how the functioning of different aspects of the stream work to keep the system healthy. After we're done, we can talk about the results of the assessment. I may recommend further assessment work to better understand what's going on. Once we understand what is happening, we can explore what you would like to accomplish with your stream and ideas for improving its condition, if necessary.

You need to assess one or more representative reaches. A reach is a length of stream. For this protocol, the length of the assessment reach is 12 times the active channel width. The reach should be representative of the stream through that area. If conditions change dramatically along the stream, you should identify additional assessment reaches and conduct separate assessments for each.

As you evaluate each element, try to work the talking points contained in the scoring descriptions into the conversation. If possible, involve the owner by asking him or her to help record the scores.

The assessment is recorded on a two-page worksheet. A completed worksheet is shown in figure 2. (A worksheet suitable for copying is at the end of this note.) The stream visual assessment protocol worksheet consists of two principal sections: reach identification and assessment. The identification section records basic information about the reach, such as name, location, and land uses. Space is provided for a diagram of the reach, which may be useful to locate the reach or illustrate problem areas. On this diagram draw all tributaries, drainage ditches, and irrigation ditches; note springs and ponds that drain to the stream; include road crossings and note whether they are fords, culverts, or bridges; note the direction of flow; and draw in any large woody debris, pools, and riffles.

The assessment section is used to record the scores for up to 15 assessment elements. Not all assessment elements will be applicable or useful for your site. Do not score elements that are not applicable. Score an element by comparing your observations to the descriptions provided. If you have difficulty matching descriptions, try to compare what you are observing to the conditions at reference sites for your area.

The overall assessment score is determined by adding the values for each element and dividing by the number of elements assessed. For example, if your scores add up to 76 and you used 12 assessment elements, you would have an overall assessment value of 6.3, which is classified as *fair*. This value provides a numerical assessment of the environmental condition of the stream reach. This value can be used as a general statement about the "state of the environment" of the stream or (over time) as an indicator of trends in condition.

Figure 2 Stream visual assessment protocol worksheet

Stream Visual Assessment Protocol

Owners name Elmer Smith Evaluator's name Mary Soylkahn Date 6-20-99

Stream name Camp Creek Waterbody ID number ______

Reach location About 2,000 feet upstream of equipment shed

Ecoregion ______ Drainage area 2,200 acres Gradient 1.2 % (map)

Applicable reference site Cherry Creek north of the Rt 310 bridge

Land use within drainage (%): row crop 40 hayland 30 grazing/pasture 20 forest 10 residential ______

confined animal feeding operations ______ Cons. Reserve ______ industrial ______ Other: ______

Weather conditions-today clear Past 2-5 days clear

Active channel width 15 feet Dominant substrate: boulder ______ gravel X sand X silt ______ mud ______

Site Diagram

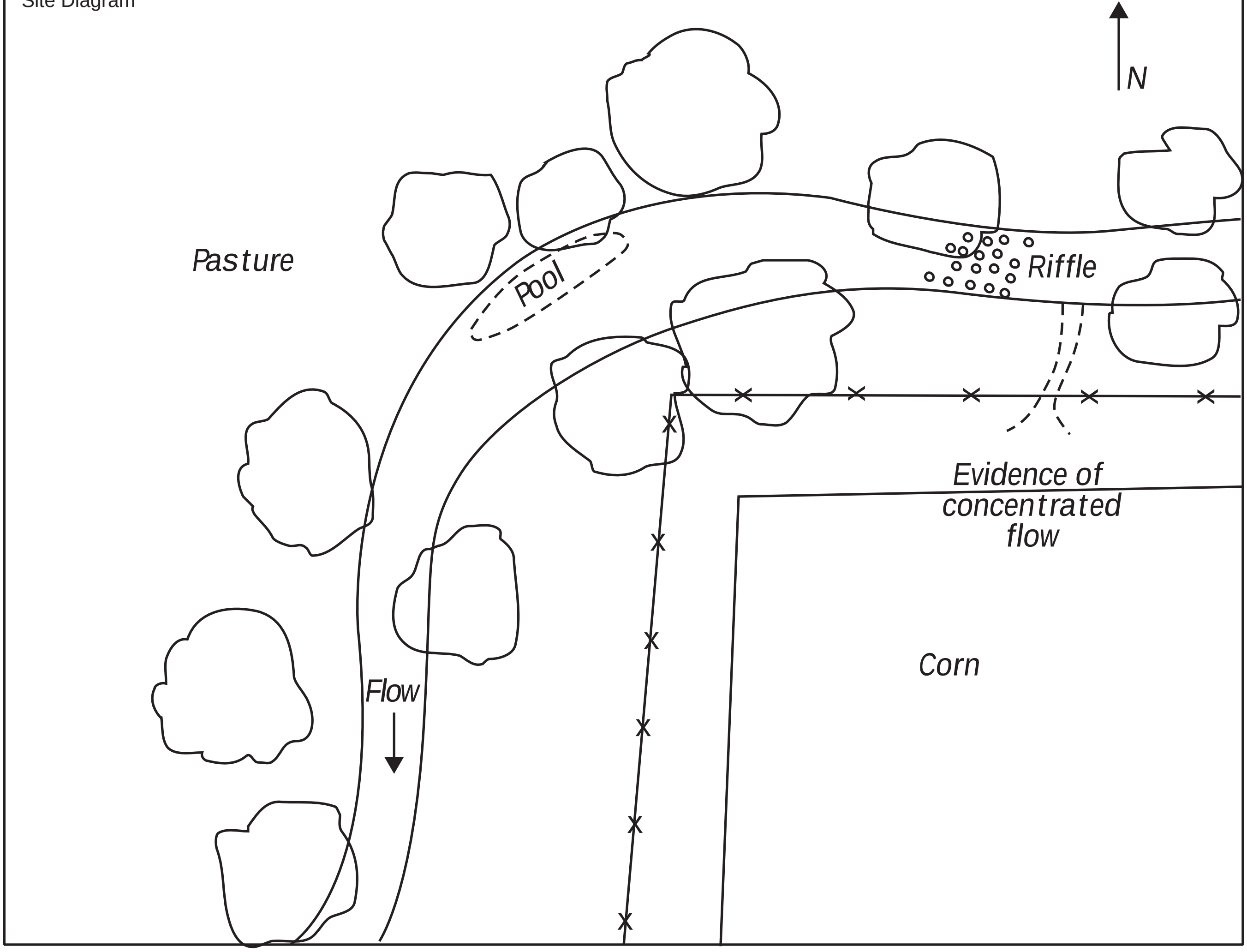


Figure 2 Stream visual assessment protocol worksheet—Continued

Assessment Scores

Channel condition	8
Hydrologic alteration	10
Riparian zone	1
Bank stability	5
Water appearance	3
Nutrient enrichment	7
Barriers to fish movement	10
Instream fish cover	3
Pools	3
Invertebrate habitat	7

Score only if applicable

Canopy cover	3
Manure presence	1
Salinity	
Riffle embeddedness	5
Marcroinvertebrates Observed (optional)	10

Overall score
(Total divided by number scored)
76/14 5.4

<6.0	**Poor**
6.1-7.4	**Fair**
7.5-8.9	**Good**
>9.0	**Excellent**

Suspected causes of observed problems This reach is typical of the reaches on the property. Severely degraded riparian zones lack brush, small trees. Some bank problems from livestock access. Channel may be widening due to high sediment load. Does not appear to be downcutting.

Recommendations Install 391-Riparian Forest Buffer. Need to encourage livestock away from stream using water sources and shade or exclude livestock. Concentrated flows off fields need to be spread out in zone 3 of buffer. Relocate fallen trees if they deflect current into bank–use as stream barbs to deflect current to maintain channel.

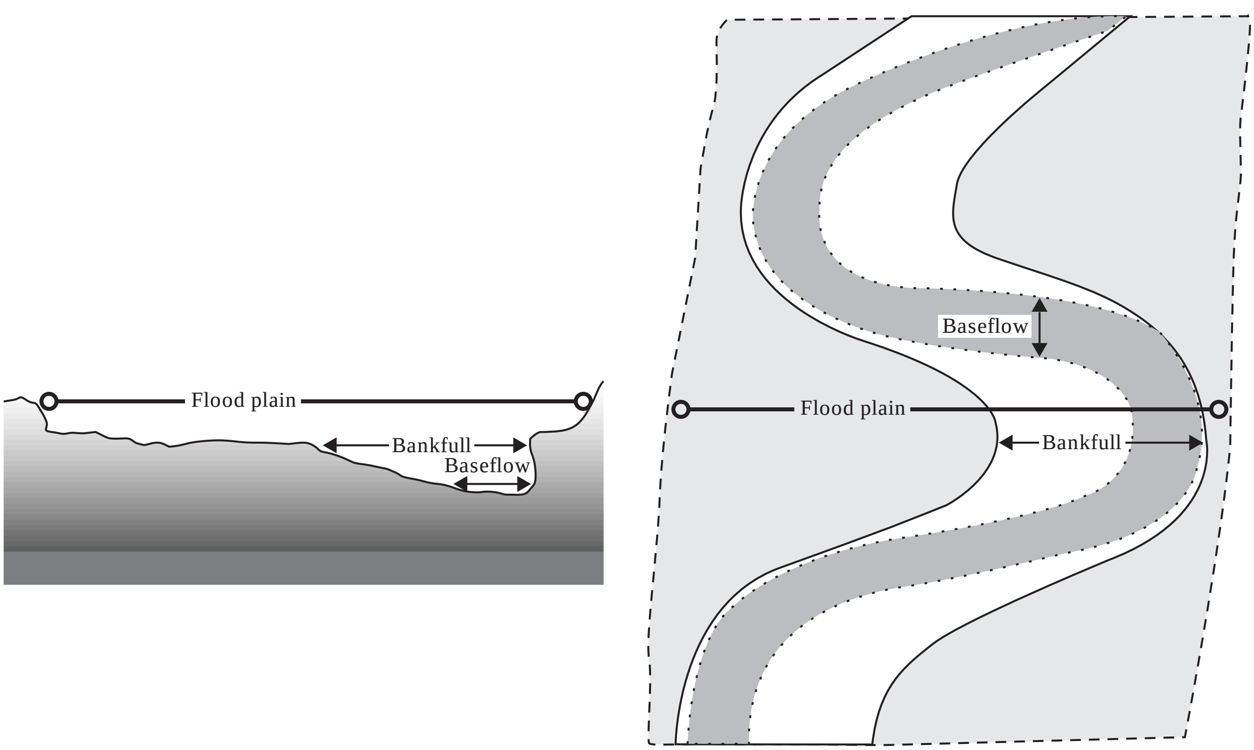
Reach description

The first page of the assessment worksheet records the identity and location of the stream reach. Most entries are self-explanatory. Waterbody ID and ecoregion should be filled out only if these identification and classification aids are used in your state.

Active channel width can be difficult to determine. However, active channel width helps to characterize the stream. It is also an important aspect of more advanced assessment protocols; therefore, it is worth becoming familiar with the concept and field determination. For this protocol you do not need to measure active channel width accurately — a visual estimate of the average width is adequate.

Active channel width is the stream width at the bankfull discharge. Bankfull discharge is the flow rate that forms and controls the shape and size of the active channel. It is approximately the flow rate at which the stream begins to move onto its flood plain if the stream has an active flood plain. The bankfull discharge is expected to occur every 1.5 years on average. Figure 3 illustrates the relationship between baseflow, bankfull flow, and the flood plain. Active channel width is best determined by locating the first flat depositional surface occurring above the bed of the stream (i.e., an active flood plain). The lowest elevation at which the bankfull surface could occur is at the top of the point bars or other sediment deposits in the channel bed. Other indicators of the bankfull surface include a break in slope on the bank, vegetation change, substrate, and debris. If you are not trained in locating the bankfull stage, ask the landowner how high the water gets every year and observe the location of permanent vegetation.

Figure 3 Baseflow, bankfull, and flood plain locations (Rosgen 1996)



Scoring descriptions

Each assessment element is rated with a value of 1 to 10. Rate only those elements appropriate to the stream. Using the Stream Visual Assessment Protocol worksheet, record the score that best fits the observations you make based on the narrative descriptions provided. Unless otherwise directed, assign the lowest score that applies. For example, if a reach has aspects of several narrative descriptions, assign a score based on the lowest scoring description that contains indicators present within the reach. You may record values intermediate to those listed. Some background information is provided for each assessment element, as well as a description of what to look for. The length of the assessment reach should be 12 times the active channel width.

Channel condition

Natural channel; no structures, dikes. No evidence of downcutting or excessive lateral cutting.	Evidence of past channel alteration, but with significant recovery of channel and banks. Any dikes or levies are set back to provide access to an adequate flood plain.	Altered channel; <50% of the reach with riprap and/or channelization. Excess aggradation; braided channel. Dikes or levees restrict flood plain width.	Channel is actively downcutting or widening. >50% of the reach with riprap or channelization. Dikes or levees prevent access to the flood plain.
10	7	3	1

Stream meandering generally increases as the gradient of the surrounding valley decreases. Often, development in the area results in changes to this meandering pattern and the flow of a stream. These changes in turn may affect the way a stream naturally does its work, such as the transport of sediment and the development and maintenance of habitat for fish, aquatic insects, and aquatic plants. Some modifications to stream channels have more impact on stream health than others. For example, channelization and dams affect a stream more than the presence of pilings or other supports for road crossings.

Active downcutting and excessive lateral cutting are serious impairments to stream function. Both conditions are indicative of an unstable stream channel. Usually, this instability must be addressed before committing time and money toward improving other stream problems. For example, restoring the woody vegetation within the riparian zone becomes increasingly difficult when a channel is downcutting because banks continue to be undermined and the water table drops below the root zone of the plants during their growing season. In this situation or when a channel is fairly stable, but already incised from previous downcutting or mechanical dredging, it is usually necessary to plant upland species, rather than hydrophytic, or to apply irrigation for several growing seasons, or both. Extensive bank-armoring of channels to stop lateral cutting usually leads to more problems (especially downstream). Often stability can be obtained by using a series of structures (barbs, groins, jetties, deflectors, weirs, vortex weirs) that reduce water velocity, deflect currents, or act as gradient controls. These structures are used in conjunction with large woody debris and woody vegetation plantings. Hydrologic alterations are described next.

What to look for: Signs of channelization or straightening of the stream may include an unnaturally straight section of the stream, high banks, dikes or berms, lack of flow diversity (e.g., few point bars and deep pools), and uniform-sized bed materials (e.g., all cobbles where there should be mixes of gravel and cobble). In newly channelized reaches, vegetation may be missing or appear very different (different species, not as well developed) from the bank vegetation of areas that were not channelized. Older channelized reaches may also have little or no vegetation or have grasses instead of woody vegetation. Drop structures (such as check dams), irrigation diversions, culverts, bridge abutments, and riprap also indicate changes to the stream channel.

Indicators of downcutting in the stream channel include nickpoints associated with headcuts in the stream bottom and exposure of cultural features, such as pipelines that were initially buried under the stream. Exposed footings in bridges and culvert outlets that are higher than the water surface during low flows are other examples. A lack of sediment depositional features, such as regularly-spaced point bars, is normally an indicator of incision. A low vertical scarp at the toe of the streambank may indicate downcutting, especially if the scarp occurs on the inside of a meander. Another visual indicator of current or past downcutting is high streambanks with woody vegetation growing well below the top of the bank (as a channel incises the bankfull flow line moves downward within the former bankfull channel). Excessive bank erosion is indicated by raw banks in areas of the stream where they are not normally found, such as straight sections between meanders or on the inside of curves.

Hydrologic alteration

Flooding every 1.5 to 2 years. No dams, no water withdrawals, no dikes or other structures limiting the stream's access to the flood plain. Channel is not incised.	Flooding occurs only once every 3 to 5 years; limited channel incision. or Withdrawals, although present, do not affect available habitat for biota.	Flooding occurs only once every 6 to 10 years; channel deeply incised. or Withdrawals significantly affect available low flow habitat for biota.	No flooding; channel deeply incised or structures prevent access to flood plain or dam operations prevent flood flows. or Withdrawals have caused severe loss of low flow habitat. or Flooding occurs on a 1-year rain event or less.
10	7	3	1

Bankfull flows, as well as flooding, are important to maintaining channel shape and function (e.g., sediment transport) and maintaining the physical habitat for animals and plants. High flows scour fine sediment to keep gravel areas clean for fish and other aquatic organisms. These flows also redistribute larger sediment, such as gravel, cobbles, and boulders, as well as large woody debris, to form pool and riffle habitat important to stream biota. The river channel and flood plain exist in dynamic equilibrium, having evolved in the present climatic regime and geomorphic setting. The relationship of water and sediment is the basis for the dynamic equilibrium that maintains the form and function of the river channel. The energy of the river (water velocity and depth) should be in balance with the bedload (volume and particle size of the sediment). Any change in the flow regime alters this balance.

If a river is not incised and has access to its flood plain, decreases in the frequency of bankfull and out-of-bank flows decrease the river's ability to transport sediment. This can result in excess sediment deposition, channel widening and shallowing, and, ultimately, in *braiding* of the channel. Rosgen (1996) defines braiding as a stream with three or more smaller channels. These smaller channels are extremely unstable, rarely have woody vegetation along their banks, and provide poor habitat for stream biota. A *split channel,* however, has two or more smaller channels (called side channels) that are usually very stable, have woody vegetation along their banks, and provide excellent habitat.

Conversely, an increase in flood flows or the confinement of the river away from its flood plain (from either incision or levees) increases the energy available to transport sediment and can result in bank and channel erosion.

The low flow or baseflow during the dry periods of summer or fall usually comes from groundwater entering the stream through the stream banks and bottom. A decrease in the low-flow rate will result in a smaller portion of the channel suitable for aquatic organisms. The withdrawal of water from streams for irrigation or industry and the placement of dams often change the normal low-flow pattern. Baseflow can also be affected by management and land use within the watershed — less infiltration of precipitation reduces baseflow and increases the frequency and severity of high flow events. For example, urbanization increases runoff and can increase the frequency of flooding to every year or more often and also reduce low flows. Overgrazing and clearcutting can have similar, although typically less severe, effects. The last description in the last box refers to the increased flood frequency that occurs with the above watershed changes.

What to look for: Ask the landowner about the frequency of flooding and about summer low-flow conditions. A flood plain should be inundated during flows that equal or exceed the 1.5- to 2.0-year flow event (2 out of 3 years or every other year). Be cautious because water in an adjacent field does not necessarily indicate natural flooding. The water may have flowed overland from a low spot in the bank outside the assessment reach.

Evidence of flooding includes high water marks (such as water lines), sediment deposits, or stream debris. Look for these on the banks, on the bankside trees or rocks, or on other structures (such as road pilings or culverts).

Excess sediment deposits and wide, shallow channels could indicate a loss of sediment transport capacity. The loss of transport capacity can result in a stream with three or more channels (braiding).

Riparian zone

Natural vegetation extends at least two active channel widths on each side.	Natural vegetation extends one active channel width on each side. or If less than one width, covers entire flood plain.	Natural vegetation extends half of the active channel width on each side.	Natural vegetation extends a third of the active channel width on each side. or Filtering function moderately compromised.	Natural vegetation less than a third of the active channel width on each side. or Lack of regeneration. or Filtering function severely compromised.
10	8	5	3	1

This element is the width of the natural vegetation zone from the edge of the active channel out onto the flood plain. For this element, the word *natural* means plant communities with (1) all appropriate structural components and (2) species native to the site or introduced species that function similar to native species at reference sites.

A healthy riparian vegetation zone is one of the most important elements for a healthy stream ecosystem. The quality of the riparian zone increases with the width and the complexity of the woody vegetation within it. This zone:

- Reduces the amount of pollutants that reach the stream in surface runoff.
- Helps control erosion.
- Provides a microclimate that is cooler during the summer providing cooler water for aquatic organisms.
- Provides large woody debris from fallen trees and limbs that form instream cover, create pools, stabilize the streambed, and provide habitat for stream biota.
- Provides fish habitat in the form of undercut banks with the "ceiling" held together by roots of woody vegetation.
- Provides organic material for stream biota that, among other functions, is the base of the food chain in lower order streams.
- Provides habitat for terrestrial insects that drop in the stream and become food for fish, and habitat and travel corridors for terrestrial animals.
- Dissipates energy during flood events.
- Often provides the only refuge areas for fish during out-of-bank flows (behind trees, stumps, and logs).

The type, timing, intensity, and extent of activity in riparian zones are critical in determining the impact on these areas. Narrow riparian zones and/or riparian zones that have roads, agricultural activities, residential or commercial structures, or significant areas of bare soils have reduced functional value for the stream. The filtering function of riparian zones can be compromised by concentrated flows. No evidence of concentrated flows through the zone should occur or, if concentrated flows are evident, they should be from land areas appropriately buffered with vegetated strips.

What to look for: Compare the width of the riparian zone to the active channel width. In steep, V-shaped valleys there may not be enough room for a flood plain riparian zone to extend as far as one or two active channel widths. In this case, observe how much of the flood plain is covered by riparian zone. The vegetation must be natural and consist of all of the structural components (aquatic plants, sedges or rushes, grasses, forbs, shrubs, understory trees, and overstory trees) appropriate for the area. A common problem is lack of shrubs and understory trees. Another common problem is lack of regeneration. The presence of only mature vegetation and few seedlings indicates lack of regeneration. Do not consider incomplete plant communities as natural. Healthy riparian zones on both sides of the stream are important for the health of the entire system. If one side is lacking the protective vegetative cover, the entire reach of the stream will be affected. In doing the assessment, examine both sides of the stream and note on the diagram which side of the stream has problems. There should be no evidence of concentrated flows through the riparian zone that are not adequately buffered before entering the riparian zone.

Bank stability

Banks are stable; banks are low (at elevation of active flood plain); 33% or more of eroding surface area of banks in outside bends is protected by roots that extend to the base-flow elevation.	Moderately stable; banks are low (at elevation of active flood plain); less than 33% of eroding surface area of banks in outside bends is protected by roots that extend to the baseflow elevation.	Moderately unstable; banks may be low, but typically are high (flooding occurs 1 year out of 5 or less frequently); outside bends are actively eroding (overhanging vegetation at top of bank, some mature trees falling into steam annually, some slope failures apparent).	Unstable; banks may be low, but typically are high; some straight reaches and inside edges of bends are actively eroding as well as outside bends (overhanging vegetation at top of bare bank, numerous mature trees falling into stream annually, numerous slope failures apparent).
10	7	3	1

This element is the existence of or the potential for detachment of soil from the upper and lower stream banks and its movement into the stream. Some bank erosion is normal in a healthy stream. Excessive bank erosion occurs where riparian zones are degraded or where the stream is unstable because of changes in hydrology, sediment load, or isolation from the flood plain. High and steep banks are more susceptible to erosion or collapse. All outside bends of streams erode, so even a stable stream may have 50 percent of its banks bare and eroding. A healthy riparian corridor with a vegetated flood plain contributes to bank stability. The roots of perennial grasses or woody vegetation typically extend to the baseflow elevation of water in streams that have bank heights of 6 feet or less. The root masses help hold the bank soils together and physically protect the bank from scour during bankfull and flooding events. Vegetation seldom becomes established below the elevation of the bankfull surface because of the frequency of inundation and the unstable bottom conditions as the stream moves its bedload.

The type of vegetation is important. For example, trees, shrubs, sedges, and rushes have the type of root masses capable of withstanding high streamflow events, while Kentucky bluegrass does not. Soil type at the surface and below the surface also influences bank stability. For example, banks with a thin soil cover over gravel or sand are more prone to collapse than are banks with a deep soil layer.

What to look for: Signs of erosion include unvegetated stretches, exposed tree roots, or scalloped edges. Evidence of construction, vehicular, or animal paths near banks or grazing areas leading directly to the water's edge suggest conditions that may lead to the collapse of banks. Estimate the size or area of the bank affected relative to the total bank area. This element may be difficult to score during high water.

Water appearance

Very clear, or clear but tea-colored; objects visible at depth 3 to 6 ft (less if slightly colored); no oil sheen on surface; no noticeable film on submerged objects or rocks.	Occasionally cloudy, especially after storm event, but clears rapidly; objects visible at depth 1.5 to 3 ft; may have slightly green color; no oil sheen on water surface.	Considerable cloudiness most of the time; objects visible to depth 0.5 to 1.5 ft; slow sections may appear pea-green; bottom rocks or submerged objects covered with heavy green or olive-green film. or Moderate odor of ammonia or rotten eggs.	Very turbid or muddy appearance most of the time; objects visible to depth < 0.5 ft; slow moving water may be bright-green; other obvious water pollutants; floating algal mats, surface scum, sheen or heavy coat of foam on surface. or Strong odor of chemicals, oil, sewage, other pollutants.
10	7	3	1

This element compares turbidity, color, and other visual characteristics with a healthy or reference stream. The depth to which an object can be clearly seen is a measure of turbidity. Turbidity is caused mostly by particles of soil and organic matter suspended in the water column. Water often shows some turbidity after a storm event because of soil and organic particles carried by runoff into the stream or suspended by turbulence. The water in some streams may be naturally tea-colored. This is particularly true in watersheds with extensive bog and wetland areas. Water that has slight nutrient enrichment may support communities of algae, which provide a greenish color to the water. Streams with heavy loads of nutrients have thick coatings of algae attached to the rocks and other submerged objects. In degraded streams, floating algal mats, surface scum, or pollutants, such as dyes and oil, may be visible.

What to look for: Clarity of the water is an obvious and easy feature to assess. The deeper an object in the water can be seen, the lower the amount of turbidity. Use the depth that objects are visible only if the stream is deep enough to evaluate turbidity using this approach. For example, if the water is clear, but only 1 foot deep, do not rate it as if an object became obscured at a depth of 1 foot. This measure should be taken after a stream has had the opportunity to "settle" following a storm event. A pea-green color indicates nutrient enrichment beyond what the stream can naturally absorb.

Nutrient enrichment

Clear water along entire reach; diverse aquatic plant community includes low quantities of many species of macrophytes; little algal growth present.	Fairly clear or slightly greenish water along entire reach; moderate algal growth on stream substrates.	Greenish water along entire reach; overabundance of lush green macrophytes; abundant algal growth, especially during warmer months.	Pea green, gray, or brown water along entire reach; dense stands of macrophytes clog stream; severe algal blooms create thick algal mats in stream.
10	7	3	1

Nutrient enrichment is often reflected by the types and amounts of aquatic vegetation in the water. High levels of nutrients (especially phosphorus and nitrogen) promote an overabundance of algae and floating and rooted macrophytes. The presence of some aquatic vegetation is normal in streams. Algae and macrophytes provide habitat and food for all stream animals. However, an excessive amount of aquatic vegetation is not beneficial to most stream life. Plant respiration and decomposition of dead vegetation consume dissolved oxygen in the water. Lack of dissolved oxygen creates stress for all aquatic organisms and can cause fish kills. A landowner may have seen fish gulping for air at the water surface during warm weather, indicating a lack of dissolved oxygen.

What to look for: Some aquatic vegetation (rooted macrophytes, floating plants, and algae attached to substrates) is normal and indicates a healthy stream. Excess nutrients cause excess growth of algae and macrophytes, which can create greenish color to the water. As nutrient loads increase the green becomes more intense and macrophytes become more lush and deep green. Intense algal blooms, thick mats of algae, or dense stands of macrophytes degrade water quality and habitat. Clear water and a diverse aquatic plant community without dense plant populations are optimal for this characteristic.

Barriers to fish movement

No barriers	Seasonal water withdrawals inhibit movement within the reach	Drop structures, culverts, dams, or diversions (< 1 foot drop) within the reach	Drop structures, culverts, dams, or diversions (> 1 foot drop) within 3 miles of the reach	Drop structures, culverts, dams, or diversions (> 1 foot drop) within the reach
10	8	5	3	1

Barriers that block the movement of fish or other aquatic organisms, such as fresh water mussels, must be considered as part of the overall stream assessment. If sufficiently high, these barriers may prevent the movement or migration of fish, deny access to important breeding and foraging habitats, and isolate populations of fish and other aquatic animals.

What to look for: Some barriers are natural, such as waterfalls and boulder dams, and some are developed by humans. Note the presence of such barriers along the reach of the stream you are assessing, their size, and whether provisions have been made for the passage of fish. Ask the landowner about any dams or other barriers that may be present 3 to 5 miles upstream or downstream. Larger dams are often noted on maps, so you may find some information even before going out into the field. Beaver dams generally do not prevent fish migration. Look for structures that may not involve a drop, but still present a hydraulic barrier. Single, large culverts with no slope and sufficient water depth usually do not constitute a barrier. Small culverts or culverts with slopes may cause high water velocities that prevent passage.

Instream fish cover

>7 cover types available	6 to 7 cover types available	4 to 5 cover types available	2 to 3 cover types available	None to 1 cover type available
10	8	5	3	1

Cover types: Logs/large woody debris, deep pools, overhanging vegetation, boulders/cobble, riffles, undercut banks, thick root mats, dense macrophyte beds, isolated/backwater pools, other: ________________________________.

This assessment element measures availability of physical habitat for fish. The potential for the maintenance of a healthy fish community and its ability to recover from disturbance is dependent on the variety and abundance of suitable habitat and cover available.

What to look for: Observe the number of different habitat and cover types *within a representative subsection of the assessment* reach that is equivalent in length to *five times* the active channel width. Each cover type must be present in appreciable amounts to score. Cover types are described below.

Logs/large woody debris—Fallen trees or parts of trees that provide structure and attachment for aquatic macroinvertebrates and hiding places for fish.

Deep pools—Areas characterized by a smooth undisturbed surface, generally slow current, and deep enough to provide protective cover for fish (75 to 100% deeper than the prevailing stream depth).

Overhanging vegetation—Trees, shrubs, vines, or perennial herbaceous vegetation that hangs immediately over the stream surface, providing shade and cover.

Boulders/cobble—Boulders are rounded stones more than 10 inches in diameter or large slabs more than 10 inches in length; cobbles are stones between 2.5 and 10 inches in diameter.

Undercut banks—Eroded areas extending horizontally beneath the surface of the bank forming underwater pockets used by fish for hiding and protection.

Thick root mats—Dense mats of roots and rootlets (generally from trees) at or beneath the water surface forming structure for invertebrate attachment and fish cover.

Dense macrophyte beds—Beds of emergent (e.g., water willow), floating leaf (e.g., water lily), or submerged (e.g., riverweed) aquatic vegetation thick enough to provide invertebrate attachment and fish cover.

Riffles—Area characterized by broken water surface, rocky or firm substrate, moderate or swift current, and relatively shallow depth (usually less than 18 inches).

Isolated/backwater pools—Areas disconnected from the main channel or connected as a "blind" side channel, characterized by a lack of flow except in periods of high water.

Pools

Deep and shallow pools abundant; greater than 30% of the pool bottom is obscure due to depth, or the pools are at least 5 feet deep.	Pools present, but not abundant; from 10 to 30% of the pool bottom is obscure due to depth, or the pools are at least 3 feet deep.	Pools present, but shallow; from 5 to 10% of the pool bottom is obscure due to depth, or the pools are less than 3 feet deep.	Pools absent, or the entire bottom is discernible.
10	7	3	1

Pools are important resting and feeding sites for fish. A healthy stream has a mix of shallow and deep pools. A *deep* pool is 1.6 to 2 times deeper than the prevailing depth, while a *shallow* pool is less than 1.5 times deeper than the prevailing depth. Pools are abundant if a deep pool is in each of the meander bends in the reach being assessed. To determine if pools are abundant, look at a longer sample length than one that is 12 active channel widths in length. Generally, only 1 or 2 pools would typically form within a reach as long as 12 active channel widths. In low order, high gradient streams, pools are abundant if there is more than one pool every 4 channel widths.

What to look for: Pool diversity and abundance are estimated based on walking the stream or probing from the streambank with a stick or length of rebar. You should find deep pools on the outside of meander bends. In shallow, clear streams a visual inspection may provide an accurate estimate. In deep streams or streams with low visibility, this assessment characteristic may be difficult to determine and should not be scored.

Insect/invertebrate habitat

At least 5 types of habitat available. Habitat is at a stage to allow full insect colonization (woody debris and logs not freshly fallen).	3 to 4 types of habitat. Some potential habitat exists, such as overhanging trees, which will provide habitat, but have not yet entered the stream.	1 to 2 types of habitat. The substrate is often disturbed, covered, or removed by high stream velocities and scour or by sediment deposition.	None to 1 type of habitat.
10	7	3	1

Cover types: Fine woody debris, submerged logs, leaf packs, undercut banks, cobble, boulders, coarse gravel, other: ____.

Stable substrate is important for insect/invertebrate colonization. *Substrate* refers to the stream bottom, woody debris, or other surfaces on which invertebrates can live. Optimal conditions include a variety of substrate types within a relatively small area of the stream (5 times the active channel width). Stream and substrate stability are also important. High stream velocities, high sediment loads, and frequent flooding may cause substrate instability even if substrate is present.

What to look for: Observe the number of different types of habitat and cover within a representative subsection of the assessment reach that is equivalent in length to five times the active channel width. Each cover type must be present in appreciable amounts to score.

Score the following assessment elements only if applicable

Canopy cover (if applicable)

Coldwater fishery

> 75% of water surface shaded and upstream 2 to 3 miles generally well shaded.	>50% shaded in reach. or >75% in reach, but upstream 2 to 3 miles poorly shaded.	20 to 50% shaded.	< 20% of water surface in reach shaded.
10	7	3	1

Warmwater fishery

25 to 90% of water surface shaded; mixture of conditions.	> 90% shaded; full canopy; same shading condition throughout the reach.	(intentionally blank)	< 25% water surface shaded in reach.
10	7		1

Do not assess this element if active channel width is greater than 50 feet. Do not assess this element if woody vegetation is naturally absent (e.g., wet meadows).

Shading of the stream is important because it keeps water cool and limits algal growth. Cool water has a greater oxygen holding capacity than does warm water. When streamside trees are removed, the stream is exposed to the warming effects of the sun causing the water temperature to increase for longer periods during the daylight hours and for more days during the year. This shift in light intensity and temperature causes a decline in the numbers of certain species of fish, insects, and other invertebrates and some aquatic plants. They may be replaced altogether by other species that are more tolerant of increased light intensity, low dissolved oxygen, and warmer water temperature. For example, trout and salmon require cool, oxygen-rich water. Loss of streamside vegetation (and also channel widening) that cause increased water temperature and decreased oxygen levels are major contributing factors to the decrease in abundance of trout and salmon from many streams that historically supported these species. Increased light and the warmer water also promote excessive growth of submerged macrophytes and algae that compromises the biotic community of the stream. The temperature at the reach you are assessing will be affected by the amount of shading 2 to 3 miles upstream.

What to look for: Try to estimate the portion of the water surface area for the whole reach that is shaded by estimating areas with no shade, poor shade, and shade. Time of the year, time of the day, and weather can affect your observation of shading. Therefore, the relative amount of shade is estimated by assuming that the sun is directly overhead and the vegetation is in full leaf-out. First evaluate the shading conditions for the reach; then determine (by talking with the landowner) shading conditions 2 to 3 miles upstream. Alternatively, use aerial photographs taken during full leaf out. The following rough guidelines for percent shade may be used:

stream surface not visible .... >90
surface slightly visible or visible only in patches .. 70 – 90
surface visible, but banks not visible................... 40 – 70
surface visible and banks visible at times .... 20 – 40
surface and banks visible .... <20

Manure presence (if applicable)

(Intentionally blank)	Evidence of livestock access to riparian zone.	Occasional manure in stream or waste storage structure located on the flood plain.	Extensive amount of manure on banks or in stream. or Untreated human waste discharge pipes present.
	5	3	1

Do not score this element unless livestock operations or human waste discharges are present.

Manure from livestock may enter the water if livestock have access to the stream or from runoff of grazing land adjacent to the stream. In some communities untreated human waste may also empty directly into streams. Manure and human waste increase biochemical oxygen demand, increase the loading of nutrients, and alter the trophic state of the aquatic biological community. Untreated human waste is a health risk.

What to look for: Do not score this element unless livestock operations or human waste discharges are present. Look for evidence of animal droppings in or around streams, on the streambank, or in the adjacent riparian zone. Well-worn livestock paths leading to or near streams also suggest the probability of manure in the stream. Areas with stagnant or slow-moving water may have moderate to dense amounts of vegetation or algal blooms, indicating localized enrichment from manure.

Salinity (if applicable)

(Intentionally blank)	Minimal wilting, bleaching, leaf burn, or stunting of aquatic vegetation; some salt-tolerant streamside vegetation.	Aquatic vegetation may show significant wilting, bleaching, leaf burn, or stunting; dominance of salt-tolerant streamside vegetation.	Severe wilting, bleaching, leaf burn, or stunting; presence of only salt-tolerant aquatic vegetation; most streamside vegetation salt tolerant.
	5	3	1

Do not assess this element unless elevated salinity from anthropogenic sources is known to occur in the stream.

High salinity levels most often occur in arid areas and in areas that have high irrigation requirements. High salinity can also result from oil and gas well operations. Salt accumulation in soil causes a breakdown of soil structure, decreased infiltration of water, and potential toxicity. High salinity in streams affects aquatic vegetation, macroinvertebrates, and fish. Salts are a product of natural weathering processes of soil and geologic material.

What to look for: High salinity levels cause a "burning" or "bleaching" of aquatic vegetation. Wilting, loss of plant color, decreased productivity, and stunted growth are readily visible signs. Other indicators include whitish salt encrustments on the streambanks and the displacement of native vegetation by salt-tolerant aquatic plants and riparian vegetation (such as tamarix or salt cedar).

Riffle embeddedness (if applicable)

Gravel or cobble particles are < 20% embedded.	Gravel or cobble particles are 20 to 30% embedded.	Gravel or cobble particles are 30 to 40% embedded.	Gravel or cobble particles are >40% embedded.	Riffle is completely embedded.
10	8	5	3	1

Do not assess this element unless riffles are present or they are a natural feature that should be present.

Riffles are areas, often downstream of a pool, where the water is breaking over rocks or other debris causing surface agitation. In coastal areas riffles can be created by shoals and submerged objects. (This element is sensitive to regional differences and should be related to reference conditions.) Riffles are critical for maintaining high species diversity and abundance of insects for most streams and for serving as spawning and feeding grounds for some fish species. Embeddedness measures the degree to which gravel and cobble substrate are surrounded by fine sediment. It relates directly to the suitability of the stream substrate as habitat for macroinvertebrates, fish spawning, and egg incubation.

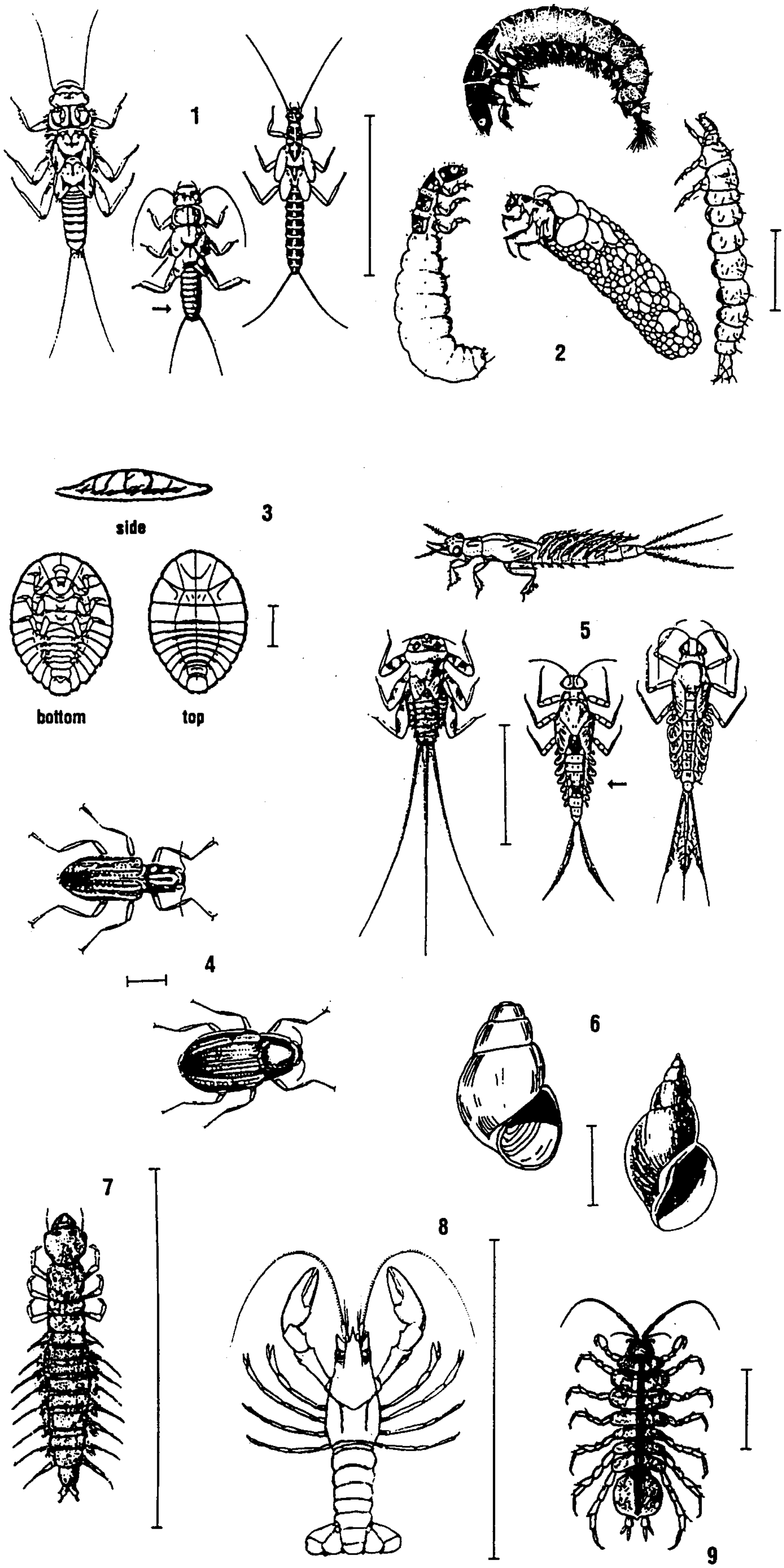
What to look for: This assessment characteristic should be used only in riffle areas and in streams where this is a natural feature. The measure is the depth to which objects are buried by sediment. This assessment is made by picking up particles of gravel or cobble with your fingertips at the fine sediment layer. Pull the particle out of the bed and estimate what percent of the particle was buried. Some streams have been so smothered by fine sediment that the original stream bottom is not visible. Test for complete burial of a streambed by probing with a length of rebar.

Macroinvertebrates observed

Community dominated by Group I or intolerant species with good species diversity. Examples include caddisflies, mayflies, stoneflies, hellgrammites.	Community dominated by Group II or facultative species, such as damselflies, dragonflies, aquatic sowbugs, blackflies, crayfish.	Community dominated by Group III or tolerant species, such as midges, craneflies, horseflies, leeches, aquatic earthworms, tubificid worms.	Very reduced number of species or near absence of all macroinvertebrates.
15	6	2	– 3

This important characteristic reflects the ability of the stream to support aquatic invertebrate animals. However, successful assessment requires knowledge of the life cycles of some aquatic insects and other macroinvertebrates and the ability to identify them. For this reason, this is an optional element. The presence of intolerant insect species (cannot survive in polluted water) indicates healthy stream conditions. Some kinds of macroinvertebrates, such as stoneflies, mayflies, and caddisflies, are sensitive to pollution and do not live in polluted water; they are considered Group I. Another group of macroinvertebrates, known as Group II or facultative macroinvertebrates, can tolerate limited pollution. This group includes damselflies, aquatic sowbugs, and crayfish. The presence of Group III macroinvertebrates, including midges, craneflies and leeches, suggests the water is significantly polluted. The presence of a single Group I species in a community does not constitute good diversity and should generally not be given a score of 15.

What to look for: You can collect macroinvertebrates by picking up cobbles and other submerged objects in the water. Look carefully for the insects; they are often well camouflaged and may appear as part of the stone or object. Note the kinds of insects, number of species, and relative abundance of each group of insects/macroinvertebrates. Each of the three classes of macroinvertebrates are illustrated on pages 19 and 20. ***Note that the scoring values for this element range from – 3 to 15.***



Bar line indicate relative size

Stream Invertebrates

Group One Taxa

Pollution sensitive organisms found in good quality water.

1 **Stonefly Order Plecoptera.** 1/2" to 1 1/2", 6 legs with hooked tips, antennae, 2 hair-line tails. Smooth (no gills) on lower half of body (see arrow).

2 **Caddisfly: Order Trichoptera.** Up to 1", 6 hooked legs on upper third of body, 2 hooks at back end. May be in a stick, rock, or leaf case with its head sticking out. May have fluffy gill tufts on under-side.

3 **Water Penny: Order Coleoptera.** 1/4", flat saucer-shaped body with a raised bump on one side and 6 tiny legs and fluffy gills on the other side. Immature beetle.

4 **Riffle Beetle: Order Coleoptera.** 1/4", oval body covered with tiny hairs, 6 legs, antennae. Walks slowly underwater. Does not swim on surface.

5 **Mayfly: Order Ephemeroptera.** 1/4" to 1", brown, moving, plate-like or feathery gills on the sides of lower body (see arrow), 6 large hooked legs, antennae, 2 or 3 long hair-like tails. Tails may be webbed together.

6 **Gilled Snail: Class Gastropoda.** Shell opening covered by thin plate called operculum. When opening is facing you, shell usually opens on right.

7 **Dobsonfly (Hellgrammite): Family Corydalidae.** 3/4" to 4", dark-colored, 6 legs, large pinching jaws, eight pairs feelers on lower half of body with paired cotton-like gill tufts along underside, short antennae, 2 tails, and 2 pairs of hooks at back end.

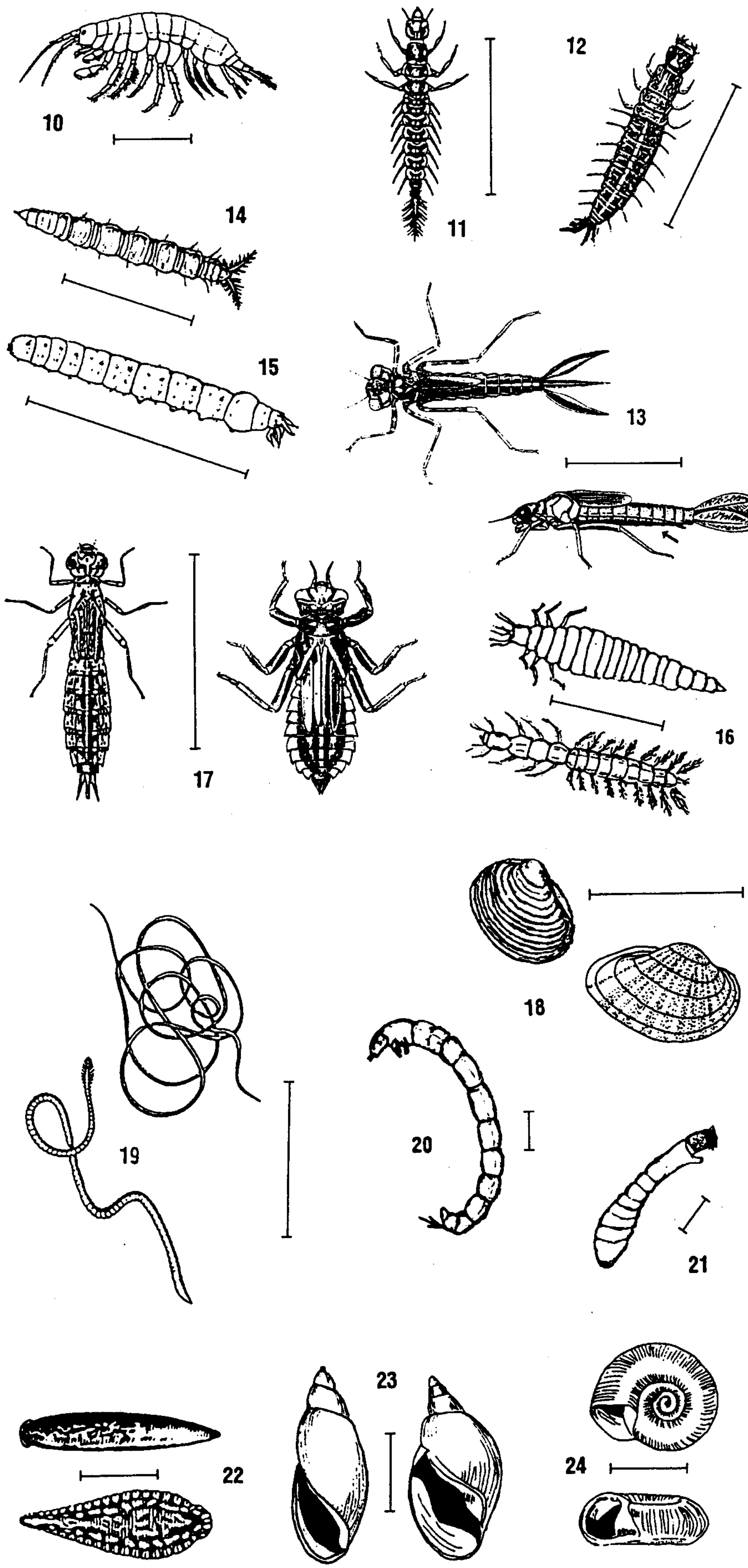
Group Two Taxa

Somewhat pollution tolerant organisms can be in good or fair quality water.

8 **Crayfish: Order Decapoda.** Up to 6", 2 large claws, 8 legs, resembles small lobster.

9 **Sowbug: Order Isopoda.** 1/4" to 3/4", gray oblong body wider than it is high, more than 6 legs, long antennae.

Source: Izaak Walton League of America, 707 Conservation Lane, Gaithersburg, MD 20878-2983. (800) BUG-IWLA



Bar line indicate relative size

Group Two Taxa

Somewhat pollution tolerant organisms can be in good or fair quality water.

10 **Scud: Order Amphipoda.** 1/4", white to gray, body higher than it is wide, swims sideways, more than 6 legs, resembles small shrimp.

11 **Alderfly Larva: Family Sialedae.** 1" long. Looks like small Hellgramite but has long, thin, branched tail at back end (no hooks). No gill tufts underneath.

12 **Fishfly Larva: Family Cordalidae.** Up to 1 1/2" long. Looks like small hellgramite but often a lighter reddish-tan color, or with yellowish streaks. No gill tufts underneath.

13 **Damselfly: Suborder Zygoptera.** 1/2" to 1", large eyes, 6 thin hooked legs, 3 broad oar-shaped tails, positioned like a tripod. Smooth (no gills) on sides of lower half of body. (See arrow.)

14 **Watersnipe Fly Larva: Family Athericidae (Atherix).** 1/4" to 1", pale to green, tapered body, many caterpillar-like legs, conical head, feathery "horns" at back end.

15 **Crane Fly: Suborder Nematocera.** 1/3" to 2", milky, green, or light brown, plump caterpillar-like segmented body, 4 finger-like lobes at back end.

16 **Beetle Larva: Order Coleoptera.** 1/4" to 1", light-colored, 6 legs on upper half of body, feelers, antennae.

17 **Dragon Fly: Suborder Anisoptera.** 1/2" to 2", large eyes, 6 hooked legs. Wide oval to round abdomen.

18 **Clam: Class Bivalvia.**

Group Three Taxa

Pollution tolerant organisms can be in any quality of water.

19 **Aquatic Worm: Class Oligochaeta.** 1/4" to 2", can be very tiny, thin worm-like body.

20 **Midge Fly Larva: Suborder Nematocera.** Up to 1/4", dark head, worm-like segmented body, 2 tiny legs on each side.

21 **Blackfly Larva: Family Simulidae.** Up to 1/4", one end of body wider. Black head, suction pad on other end.

22 **Leech: Order Hirudinea.** 1/4" to 2", brown, slimy body, ends with suction pads.

23 **Pouch Snail and Pond Snails: Class Gastropoda.** No operculum. Breath air. When opening is facing you, shell usually open to left.

24 **Other Snails: Class Gastropoda.** No operculum.Breath air. Snail shell coils in one plane.

Technical information to support implementation

Introduction

This section provides a guide for implementation of the Stream Visual Assessment Protocol (SVAP). The topics covered in this section include the origin of the protocol, development history, context for use in relation to other methods of stream assessment, instructions for modifying the protocol, and references.

Origin of the protocol

In 1996 the NRCS National Water and Climate Center surveyed the NRCS state biologists to determine the extent of activity in stream ecological assessment and the need for technical support. The survey indicated that less than a third of the NRCS states were active in supporting stream assessment within their state. Most respondents said they believed they should be more active and requested additional support from the National Centers and Institutes. In response to these findings, the NRCS Aquatic Assessment Workgroup was formed. In their first meeting the workgroup determined that a simple assessment protocol was needed. The Water Quality Indicators Guide (WQIG) had been available for 8 years, but was not being used extensively. The workgroup felt a simpler and more streamlined method was needed as an initial protocol for field office use.

The workgroup developed a plan for a tiered progression of methods that could be used in the field as conservationists became more skilled in stream assessment. These methods would also serve different assessment objectives. The first tier is a simple 2-page assessment — the Stream Visual Assessment Protocol (SVAP). The second tier is the existing WQIG. The third tier is a series of simple assessment methods that could be conducted by conservationists in the field. An example of a third tier method would be macro-invertibrate sampling and identification to the taxonomic level of Order. The fourth tier is fairly sophisticated methods used in special projects. Examples of fourth tier methods would be fish community sampling and quantitative sampling of macroinvertebrates with shipment of samples to a lab for identification.

The workgroup also found that introductory training and a field handbook that would serve as a comprehensive reference and guidance manual are needed. These projects are under development as of this writing.

Context for use

The Stream Visual Assessment Protocol is intended to be a simple, comprehensive assessment of stream condition that maximizes ease of use. It is suitable as a basic first approximation of stream condition. It can also be used to identify the need for more accurate assessment methods that focus on a particular aspect of the aquatic system.

The relationship of the SVAP to other assessment methods is shown in figure 4. In this figure a specific reference to a guidance document is provided for some methods. The horizontal bars indicate which aspects of stream condition (chemical, physical, or biological) are addressed by the method. The SVAP is the simplest method and covers all three aspects of stream condition. As you move upwards in figure 4 the methods provide more accuracy, but also become more focused on one or two aspects of stream condition and require more expertise or resources to conduct.

The SVAP is intended to be applicable nationwide. It has been designed to utilize factors that are least sensitive to regional differences. However, regional differences are a significant aspect of stream assessment, and the protocol can be enhanced by tailoring the assessment elements to regional conditions. The national SVAP can be viewed as a framework that can evolve over time to better reflect State or within-State regional differences. Instructions for modification are provided later in this document.

Development

The SVAP was developed by combining parts of several existing assessment procedures. Many of these sources are listed in the references section. Three drafts were developed and reviewed by the workgroup and others between the fall of 1996 and the spring of 1997. During the summer of 1997, the workgroup conducted a field trial evaluation of the third draft. Further field trials were conducted with the fourth draft in 1998. A report on the field trial results is appendix A of this document.

The field trials involved approximately 60 individuals and 182 assessment sites. The field trial consisted of a combination of replication studies (in which several individuals independently assessed the same sites) and accuracy studies (in which SVAP scores were compared to the results from other assessment methods). The average coefficient of variation in the replication studies was 10.5 percent. The accuracy results indicated that SVAP version 3 scores correlated well with other methods for moderately impacted and high quality sites, but that low quality sites were not scoring correspondingly low in the SVAP. Conservationists in the field who participated in the trial were surveyed on the usability and value of the protocol. The participants indicated that they found it easy to use and thought it would be valuable for their clients.

Revisions were made to the draft to address the deficiencies identified in the field trial, and some reassessments were made during the winter of 1998 to see how the revisions affected performance. Performance was improved. Additional revisions were made, and the fifth draft was sent to all NRCS state offices, selected Federal agencies, and other partners for review and comment during the spring of 1998.

Comments were received from eight NRCS state offices, the Bureau of Land Management, and several NRCS national specialists. Comments were uniformly supportive of the need for the guidance and for the document as drafted. Many commenters provided improved explanatory text for the supporting descriptions accompanying the assessment elements. Most of the suggested revisions were incorporated.

Implementation

The SVAP is issued as a national product. States are encouraged to incorporate it within the Field Office Technical Guide. The document may be modified by States. The electronic file for the document may be downloaded from the National Water and Climate Center web site at http://www.wcc.nrcs.usda.gov.

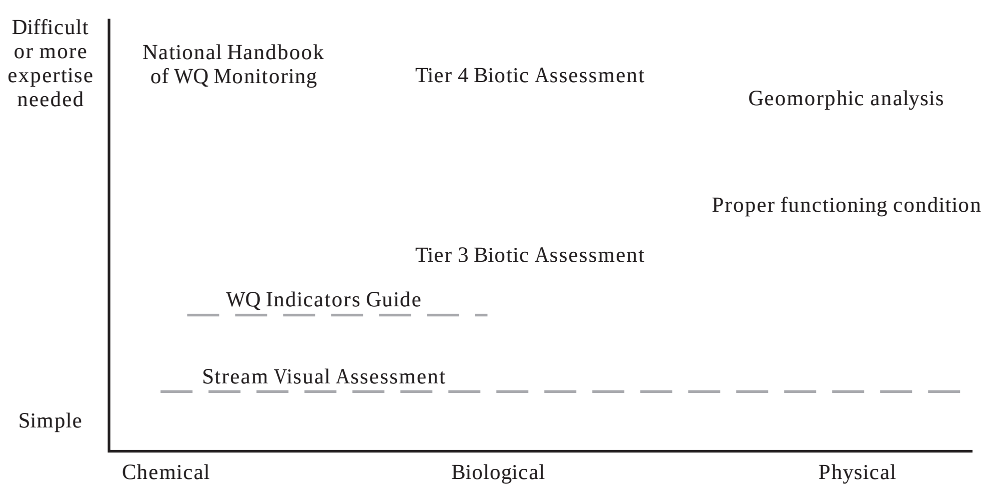
A training course for conservationists in the field suitable for use at the state or area level has been developed to facilitate implementation of the SVAP. It is designed as either a 1-day or 2-day session. The first day covers basic stream ecology and use of the SVAP. The second day includes an overview of several stream assessment methods, instruction on a macroinvertebrate survey method, and field exercises to apply the SVAP and macroinvertibrate protocols. The training materials consist of an instructor's guide, slides, video, a macroinvertebrate assessment training kit, and a student workbook. Training materials have been provided to each NRCS state office.

Instructions for modification

The national version of the Stream Visual Assessment Protocol may be used without modification. It has been designed to use assessment elements that are least sensitive to regional differences. Nonetheless, it can be modified to better reflect conditions within a geographic area. Modifying the protocol would have the following benefits:

- The protocol can be made easier to use with narrative descriptions that are closer to the conditions users will encounter.
- The protocol can be made more responsive to differences in stream condition.
- Precision can be improved by modifying elements that users have trouble evaluating.
- The rating scale can be calibrated to regionally-based criteria for excellent, good, fair, and poor condition.

Figure 4 Relationship of various stream condition assessment methods in terms of complexity or expertise required and the aspects of stream condition addressed



Two parts of the SVAP may be modified—the individual elements and their narrative descriptions, and the rating scale for assigning an overall condition rating of excellent, good, fair, or poor.

The simplest approach to modifying the SVAP is based on professional experience and judgment. Under this approach an interdisciplinary team should be assembled to develop proposed revisions. Revisions should then be evaluated by conducting comparison assessments at sites representing a range of conditions and evaluating accuracy (correlation between different assessment methods), precision (reproducibility among different users), and ease of use.

A second, more scientifically rigorous method for modifying the protocol is described below. This approach is based on a classification system for stream type and the use of reference sites.

Step 1 Decide on tentative number of versions.
Do you want to develop a revised version for your state, for each ecoregion within your state, or for several stream classes within each ecoregion?

Step 2 Develop tentative stream classification.
If you are developing protocols by stream class, you need to develop a tentative classification system. (If you are interested in a statewide or ecoregion protocol, go to step 3.) You might develop a classification system based on stream order, elevation, or landscape character. Do not create too many categories. The greater the number of categories, the more assessment work will be needed to modify the protocol and the more you will be accommodating degradation within the evaluation system. As an extreme example of the latter problem, you would not want to create a stream class consisting of those streams that have bank-to-bank cropping and at least one sewage outfall.

Step 3 Assess sites.
Assess a series of sites representing a range of conditions from highly impacted sites to least impacted sites. Try to have at least 10 sites in each of your tentative classes. Those sites should include several potential “least impacted reference sites.” Try to use sites that have been assessed by other assessment methods (such as sites assessed by state agencies or universities). As part of the assessments, be sure to record information on potential classification factors and if any particular elements are difficult to score. Take notes so that future revisions of the elements can be rescored without another site visit.

Step 4 Rank the sites.
Begin your data analysis by ranking all the sites from most impacted to least impacted. Rank sites according to the independent assessment results (preferred) or by the SVAP scores. Initially, rank all of the sites in the state data set. You will test classifications in subsequent iterations.

Step 5 Display scoring data.
Prepare a chart of the data from all sites in your state. The columns are the sites arranged by the ranking. The rows are the assessment elements, the overall numerical score, and the narrative rating. If you have independent assessment data, create a second chart by plotting the overall SVAP scores against the independent scores.

Step 6 Evaluate responsiveness.
Does the SVAP score change in response to the condition gradient represented by the different sites? Are the individual element scores responding to key resource problems? Were users comfortable with all elements? If the answers are yes, do not change the elements and proceed to step 7. If the answers are no, isolate which elements are not responsive. Revise the narrative descriptions for those elements to better respond to the observable conditions. Conduct a "desktop" reassessment of the sites with the new descriptions, and return to step 4.

Step 7 Evaluate the narrative rating breakpoints.
Do the breakpoints for the narrative rating correspond to other assessment results? The excellent range should encompass only reference sites. If not, you should reset the narrative rating breakpoints. Set the excellent breakpoint based on the least impacted reference sites. You must use judgment to set the other breakpoints.

Step 8 Evaluate tentative classification system.
Go back to step 4 and display your data this time by the tentative classes (ecoregions or stream classes). In other words, analyze sites from each ecoregion or each stream class separately. Repeat steps 5 through 7. If the responsiveness is significantly different from the responsiveness of the statewide data set or the breakpoints appear to be significantly different, adopt the classification system and revise the protocol for each ecoregion or stream class. If not, a single statewide protocol is adequate.

After the initial modification of the SVAP, the state may want to set up a process to consider future revisions. Field offices should be encouraged to locate and assess least impacted reference sites to build the data base for interpretation and future revisions. Ancillary data should be collected to help evaluate whether a potential reference site should be considered a reference site.

Caution should be exercised when considering future revisions. Revisions complicate comparing SVAP scores determined before and after the implementation of conservation practices if the protocol is substantially revised in the intervening period. Developing information to support refining the SVAP can be carried out by graduate students working cooperatively with NRCS. The Aquatic Assessment Workgroup has been conducting a pilot Graduate Student Fellowship program to evaluate whether students would be willing to work cooperatively for a small stipend. Early results indicate that students can provide valuable assistance. However, student response to advertisements has varied among states. If the pilot is successful, the program will be expanded.

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Glossary

Active channel width The width of the stream at the bankfull discharge. Permanent vegetation generally does not become established in the active channel.

Aggradation Geologic process by which a stream bottom or flood plain is raised in elevation by the deposition of material.

Bankfull discharge The stream discharge (flow rate, such as cubic feet per second) that forms and controls the shape and size of the active channel and creates the flood plain. This discharge generally occurs once every 1.5 years on average.

Bankfull stage The stage at which water starts to flow over the flood plain; the elevation of the water surface at bankfull discharge.

Baseflow The portion of streamflow that is derived from natural storage; average stream discharge during low flow conditions.

Benthos Bottom-dwelling or substrate-oriented organisms.

Boulders Large rocks measuring more than 10 inches across.

Channel A natural or artificial waterway of perceptible extent that periodically or continuously contains moving water. It has a definite bed and banks that serve to confine the water.

Channel roughness Physical elements of a stream channel upon which flow energy is expended including coarseness and texture of bed material, the curvature of the channel, and variation in the longitudinal profile.

Channelization Straightening of a stream channel to make water move faster.

Cobbles Medium-sized rocks which measure 2.5 to 10 inches across.

Confined channel A channel that does not have access to a flood plain.

Degradation Geologic process by which a stream bottom is lowered in elevation due to the net loss of substrate material. Often called downcutting.

Downcutting See Degradation.

Ecoregion A geographic area defined by similarity of climate, landform, soil, potential natural vegetation, hydrology, or other ecologically relevant variables.

Embeddedness The degree to which an object is buried in steam sediment.

Emergent plants Aquatic plants that extend out of the water.

Flood plain The flat area of land adjacent to a stream that is formed by current flood processes.

Forb Any broad-leaved herbaceous plant other than those in the Gramineae (Poceae), Cyperacea, and Juncaceae families (Society for Range Management, 1989).

Gabions A wire basket filled with rocks; used to stabilize streambanks and to control erosion.

Geomorphology The study of the evolution and configuration of landforms.

Glide A fast water habitat type that has low to moderate velocities, no surface agitation, no defined thalweg, and a U-shaped, smooth, wide bottom.

Gradient Slope calculated as the amount of vertical rise over horizontal run expressed as ft/ft or as percent (ft/ft * 100).

Grass An annual to perennial herb, generally with round erect stems and swollen nodes; leaves are alternate and two-ranked; flowers are in spikelets each subtended by two bracts.

Gravel Small rocks measuring 0.25 to 2.5 inches across.

Habitat The area or environment in which an organism lives.

Herbaceous Plants with nonwoody stems.

Hydrology The study of the properties, distribution, and effects of water on the Earth's surface, soil, and atmosphere.

Incised channel A channel with a streambed lower in elevation than its historic elevation in relation to the flood plain.

Intermittent stream A stream in contact with the ground water table that flows only certain times of the year, such as when the ground water table is high or when it receives water from surface sources.

Macrophyte bed A section of stream covered by a dense mat of aquatic plants.

Meander A winding section of stream with many bends that is at least 1.2 times longer, following the channel, than its straight-line distance. A single meander generally comprises two complete opposing bends, starting from the relatively straight section of the channel just before the first bend to the relatively straight section just after the second bend.

Macroinvertebrate A spineless animal visible to the naked eye or larger than 0.5 millimeters.

Nickpoint The point where a stream is actively eroding (downcutting) to a new base elevation. Nickpoints migrate upstream (through a process called headcutting).

Perennial stream A steam that flows continuously throughout the year.

Point bar A gravel or sand deposit on the inside of a meander; an actively mobile river feature.

Pool Deeper area of a stream with slow-moving water.

Reach A section of stream (defined in a variety of ways, such as the section between tributaries or a section with consistent characteristics).

Riffle A shallow section in a stream where water is breaking over rocks, wood, or other partly submerged debris and producing surface agitation.

Riparian The zone adjacent to a stream or any other waterbody (from the Latin word ripa, pertaining to the bank of a river, pond, or lake).

Riprap Rock material of varying size used to stabilize streambanks and other slopes.

Run A fast-moving section of a stream with a defined thalweg and little surface agitation.

Scouring The erosive removal of material from the stream bottom and banks.

Sedge A grasslike, fibrous-rooted herb with a triangular to round stem and leaves that are mostly three-ranked and with close sheaths; flowers are in spikes or spikelets, axillary to single bracts.

Substrate The mineral or organic material that forms the bed of the stream; the surface on which aquatic organisms live.

Surface fines That portion of streambed surface consisting of sand/silt (less than 6 mm).

Thalweg The line followed by the majority of the streamflow. The line connecting the lowest or deepest points along the streambed.

Turbidity Murkiness or cloudiness of water caused by particles, such as fine sediment (silts, clays) and algae.

Watershed A ridge of high land dividing two areas that are drained by different river systems. The land area draining to a waterbody or point in a river system; catchment area, drainage basin, drainage area.

Appendix A—1997 and 1998 Field Trial Results

Purpose and methods

The purpose of the field trials was to evaluate the accuracy, precision, and usability of the draft Steam Visual Assessment Protocol. The draft protocols evaluated were the third draft dated May 1997 and the fourth draft dated October 1997. A field trial workplan was developed with study guidelines and a survey form to solicit feedback from users. Accuracy was evaluated by comparison to other stream assessment methods. Precision was evaluated by replicate assessments conduced by different individuals at the same sites. In all studies an attempt was made to utilize sites ranging from high quality to degraded. Results consisted of the scoring data and the user feedback form for each site.

Results

Overall, 182 sites were assessed, and approximately 60 individuals participated in the field trials. The individual studies are summarized in table A–1.

Precision could be evaluated using data from the Colorado, New Jersey, Oregon, Virginia, and Georgia studies. Results are summarized in table A–2. The New Jersey sites had coefficients of variation of 9.0 (n=8), 14.4 (n=5), and 5.7 (n=4) percent. The Oregon site with three replicates was part of a course and had a coefficient of variation of 11.1 percent. One Georgia site was assessed using the fourth draft during a pilot of the training course. There were 11 replicates, and the coefficient of variation was 8.8 percent. In May 1998 the workgroup conducted replicate assessments of two sites in Virginia using the fifth draft of the protocol. Coefficients of variation were 14.7 and 3.6 percent. The average coefficient of variation of all studies in table A–2 is 10.5 percent.

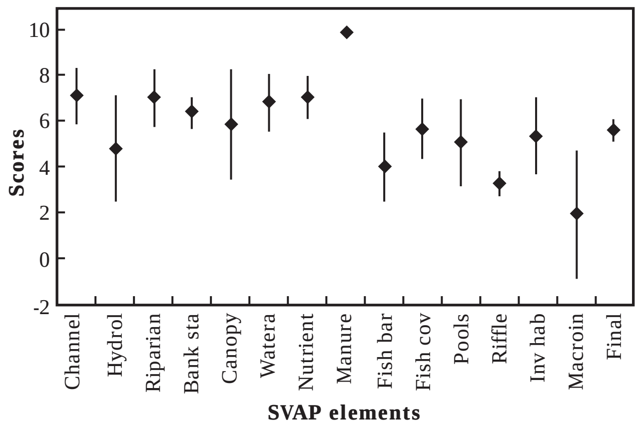
Variability within the individual elements of the SVAP was evaluated using the Georgia site with 11 replicates. The results of the individual element scores are presented in figure A–1. It should be noted that two individuals erroneously rated the "presence of manure" element.

Accuracy was evaluated by comparing the SVAP rating to other methods as noted in table A–1. Some of the comparisons involved professional judgment. In others the SVAP score could be compared with a quantitative evaluation. Figures A–2 through A–5 present data from the two studies that had larger numbers of sites. The Pearson's Correlation Coefficient is presented for these data. The results from other sites are presented in table A–3.

Table A–1 Summary of studies in the field trial

Location	Number of sites	Number of replicates	SVAP compared to	SVAP conducted by
VA	56	3, 5	IBI (fish) and Ohio QHEI	FO personnel
NC/SC	90	none	IBI, EPT	Soil scientists
MI	5	none	professional judgment	State biologist
NJ	3	4, 5, 8	NJDEP ratings	FO personnel
OR	3	none	IBI	NWCC scientist
CO	1	3	professional judgment	FO personnel
WA	3	none	professional judgment	State biologist
OR	2	3	no comparisons	FO personnel
GA	8	4-5	macroinvertebrates	FO personnel
GA	2	12, none	IBI, macroinvertebrate	FO personnel

Figure A–1 Means and standard deviations from the Parker's Mill Creek site in Americus, GA (n=11) (mean plus and minus one standard deviation is shown; SVAP version 4 used)



The SVAP version 3 scores correlated extremely well with the Ohio Qualitative Habitat Index and reasonably well with the fish community IBI in the Virginia study (fig. A–2 and A–3). However, the SVAP version 3 scores in the Carolinas study did not correlate well with either IBI or EPT Taxa (fig. A–4 and A–5). These results may reflect the fact that the SVAP primarily assesses physical habitat within the assessment reach whereas IBI and EPT Taxa are influenced by both physical habitat within the assessment reach and conditions within the watershed. Onsite physical habitat may have been a relatively more important factor at the Virginia sites than at the Carolina sites.

Overall, the field trial results for the third draft seemed to indicate that SVAP scores reflected conditions for sites in good to moderate condition. However, SVAP scores tended to be too high for poor quality sites.

Both the user questionnaires and verbal feedback indicated that users found the SVAP easy to use. Users reported that they thought it would be an effective tool to use with landowners. The majority indicated that they would recommend it to landowners.

Table A–2 Summary of replication results (version refers to the SVAP draft used; mean for overall score reported)

Site	SVAP version	No. replicates	Mean [1/]	Standard deviation	Coefficient of variation
Alloway Cr. NJ	3	5	3.6 F	0.52	14.4
Manasquan R. NJ	3	4	5.1 G	0.29	5.7
S. Br. Raritan R. NJ	3	8	5.9 G	0.53	9.0
Gales Cr. OR	3	3	5.5 G	0.61	11.1
Clear Cr. CO	3	3	5.4 G	0.74	13.7
Piscola Cr. GA #1	4	5	9.2 E	0.77	8.4
Piscola Cr. GA #2	4	5	9.0 E	0.85	9.4
Piscola Cr. GA #3	4	4	4.7 F	1.10	23.4
Piscola Cr. GA #4	4	4	7.4 G	0.96	13.0
Little R. GA # 1	4	4	8.3 E	0.73	8.8
Little R. GA # 2	4	4	7.4 E	0.83	11.2
Little R. GA # 3	4	4	8.1 E	0.41	5.1
Little R. GA # 4	4	4	7.3 G	0.60	8.2
Parker's Mill Cr. GA	4	11	5.7 F	0.50	8.8
Cedar Run (up), VA	5	5	7.7 G	1.1	14.7
Cedar R. (down), VA	5	5	6.6 F	.2	3.6

1/ Includes SVAP narrative ratings (P = poor, F = fair, G = good, E = excellent)

Table A–3 Accuracy comparison data from studies with too few sites to determine a correlation coefficient

Site	SVAP version	SVAP score and rating	Comparative rating	Comparative method
Alloway Cr. NJ	3	3.6* — fair	12 — mod. impaired	NJIS (macro.)
Manasquan R. NJ	3	5.1* — good	12 — mod. impaired	NJIS (macro.)
S. Br. Raritan R. NJ	3	5.9* — good	30 — not impaired	NJIS (macro.)
Site 1 OR	3	2.7 — fair	12 — very poor	IBI (fish)
Site 2 OR	3	4.6 — good	22 — poor	IBI (fish)
Site 3 OR	3	7.0 — excellent	44 — good	IBI (fish)
Muckalee Cr. GA	4	8.6 — good	good to excellent	mussel taxa

* Mean value of replicates

Figure A–2 Correlation between SVAP and IBI values in the Virginia study (n=56)

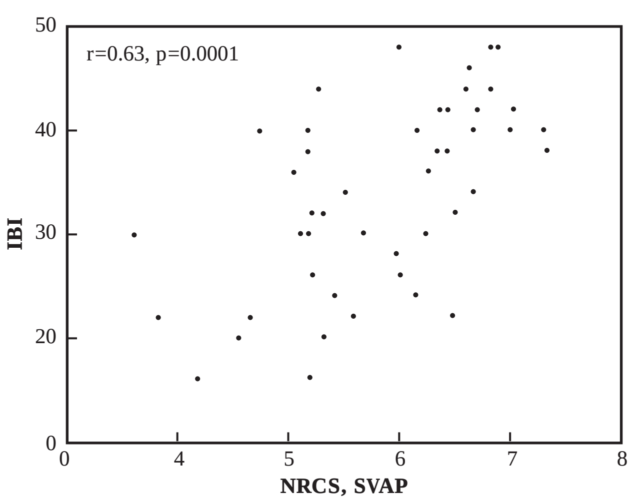


Figure A–3 Correlation between SVAP and Ohio Qualitative Habitat Evaluation Index values in the Virginia study (n=56)

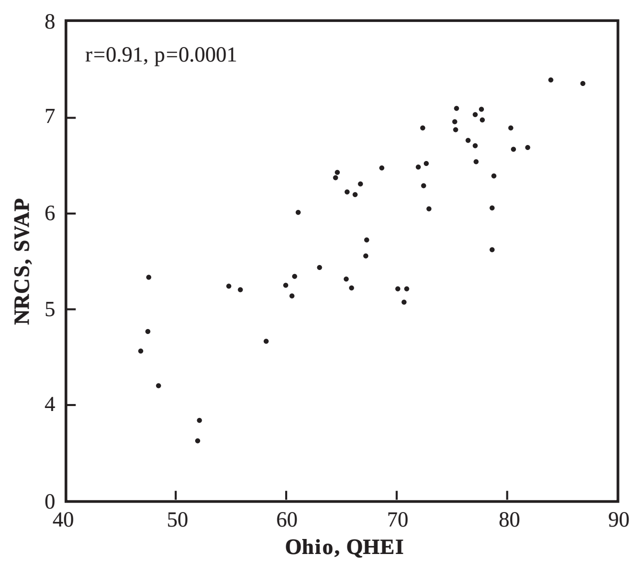


Figure A–4 Correlation between SVAP and IBI values in the Carolinas study (n=90)

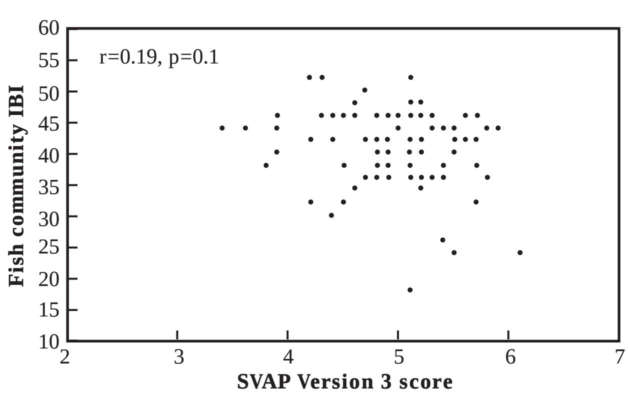
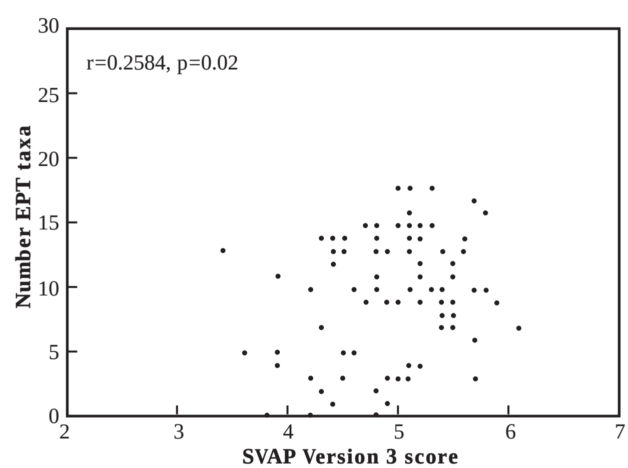


Figure A–5 Correlation between SVAP and macroinvertebrate index values in Carolinas study (n=90)



Discussion

Overall, the workgroup concluded from the first field trial that the SVAP could be used by conservationists in the field with reasonable reproducibility and a level of accuracy commensurate with its objective of providing a basic assessment of ecological condition provided the poor response to degraded streams could be corrected.

Several potential causes for the lack of accuracy with degraded sites were identified by the workgroup as follows:

- Because the overall score is an average of all assessed elements, the effect of low scoring elements can be damped out by averaging if the degradation is not picked up by many of the other assessed elements.
- Some of the elements needed to be adjusted to give lower scores for problems.
- The numerical breakpoints for the narrative ratings of poor/fair and fair/good were set too low.

To correct these problems the number of assessment elements was reduced and the instructions were modified so that certain elements are not scored if they do not apply. For example, the "presence of manure" element is not scored unless there are animal operations present. These changes reduced the potential for low scores to be damped out by the averaging process.

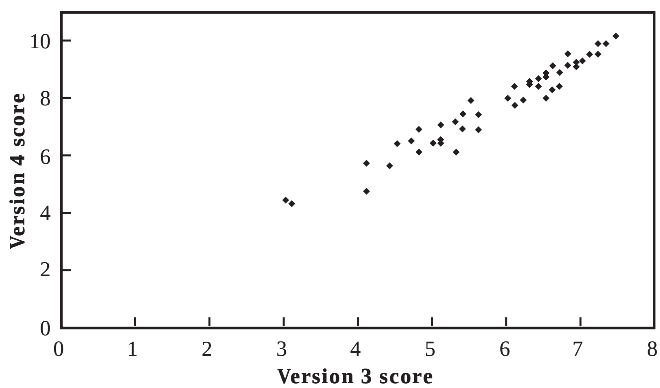
Several elements were also rewritten to reduce ambiguity at the low end of the rating scale. Additionally, several elements were rewritten to have five narrative descriptions instead of four to address a concern that users might err on the high side. The scoring scale was changed from a scale of 1 to 7 to a scale of 1 to 10 because it was felt that most people have a tendency to think in terms of a decimal scale.

The revisions were incorporated into a fourth draft and evaluated by the workgroup. Sites from the first field trial were rescored using the new draft. Response seemed to have improved as indicated by the greater separation of sites at lower scores in figure A–6.

During pilot testing of the training materials in March 1998, the fourth draft was used by 12 students independently at one site and collectively at another site. The coefficient of variation at the replication site was 8.8 percent. One of the sites had been previously assessed using other methods, and the SVAP rating corresponded well to the previous assessments.

After the evaluation of the fourth draft, minor revisions were made for the fifth draft. The breakpoints for the narrative rating of excellent, good, fair, and poor for the fifth draft were set using the Virginia data set. These breakpoints may be adjusted by the NRCS state office as explained in this document.

Figure A–6 Version 4 scores for VA plotted against version 3 scores (n=56)



Stream Visual Assessment Protocol

Owners name ____________________________ Evaluator's name_________________________ Date ____________

Stream name _____________________________________ Waterbody ID number ______________________________

Reach location ____

____

Ecoregion ____________________________ Drainage area ____________________ Gradient_____________________

Applicable reference site ____

Land use within drainage (%): row crop ______ hayland ______ grazing/pasture _______ forest ______ residential _______

confined animal feeding operations ______ Cons. Reserve ________ industrial _______ Other: _________________

Weather conditions-today _________________________________ Past 2-5 days ___________________________________

Active channel width ____________________ Dominant substrate: boulder ______ gravel ______ sand ______ silt ______ mud ______

Site Diagram

Assessment Scores

Channel condition	
Hydrologic alteration	
Riparian zone	
Bank stability	
Water appearance	
Nutrient enrichment	
Barriers to fish movement	
Instream fish cover	
Pools	
Invertebrate habitat	

Score only if applicable

Canopy cover	
Manure presence	
Salinity	
Riffle embeddedness	
Marcroinvertebrates Observed (optional)	

Overall score
(Total divided by number scored) ___________

<6.0	**Poor**
6.1-7.4	**Fair**
7.5-8.9	**Good**
>9.0	**Excellent**

Suspected causes of observed problems____

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Recommendations____

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